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by

© Shawn Thomas Carson

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled A COMPARISON OF THE ALBERTA OCCUPATIONAL HEALTH AND SAFETY ACT (1976) AND THE OPERATIONAL NOISE EXPOSURE LEVELS WITHIN THE SENIOR HIGH INDUSTRIAL ARTS LABORATORIES OF THE EDMONTON PUBLIC SCHOOL BOARD

submitted by SHAWN THOMAS CARSON

in partial fulfilment of the requirements for the degree of Master of Education in Industrial Arts

ABSTRACT

This study was concerned with the problem of noise exposure levels in the senior high industrial arts laboratory facilities of the Edmonton Public School Board. More precisely, the study compared the standard for noise exposure of 85 dBA/8 hour limit, or equivalent, as stated in the regulations of The Alberta Occupational Health and Safety Act (1976) and the operational noise exposure levels in the seven senior high industrial arts laboratories that comprised the population of the research.

To collect data relating to the noise exposure levels in the following four technology areas - Electronics Technology, Materials Technology, Power Technology, and Visual Communications Technology, a noise dosimeter was used. Because this instrument is used by occupational hygienists and industrial audiologists in their work, and because this instrument must pass the stringent standards of standards-writing organizations, it was considered to be a reliable instrument for the purposes of this research.

The findings of this study show that the noise exposure levels in the Electronics and Visual Communications Technology areas are within the 85 dBA/8 hour, equal or equivalent, noise exposure limitation of The Alberta Occupational Health and Safety Act (1976). In fact, levels in these technology areas were so low, they were considered innocuous.

For Power Technology, it was found that the noise levels generated could possibly present a hearing safety hazard in some of the laboratories monitored. Further, in two of the five laboratories that offered this technology, the equivalent noise exposure levels were above

the 50 percent "level for concern" advocated by the Occupational Hygiene Branch, Alberta Labour, and levels in excess of 115 dBA were reported.

The equivalent noise exposure levels for six of the seven schools tested were highest in the Materials Technology area. Noise exposures were extreme to the extent that the 85 dBA/8 hour exposure limitation was violated in three of the six schools offering this technology. In all six schools, levels in excess of 115 dBA were reported. Because of the high noise level exposures produced in Materials Technology, the existence of a potential hearing hazard, for students and teachers working in this area, seems possible.

The research data revealed that none of the staff or students in any of the areas or facilities monitored wore any form of hearing protection whatever. In addition, a majority of the industrial arts teachers who participated in the study, expressed concern over the operational noise levels that existed in their laboratories.

On the basis of the research data obtained the findings and conclusions of this study were formulated. From these, recommendations were made to the administrative personnel of the Edmonton Public School Board; to the regulatory agency - the Occupational Hygiene Branch, Alberta Labour; to the Industrial Arts Teachers who were involved in this study; and finally, to Teacher Educators.

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Chapter 1

INTRODUCTION

By the close of the 18th century, the Industrial Revolution was in full swing in England and within the span of the next century, this phenomenon of rapid technological innovation had implanted itself throughout the entire civilized, western world. With the machine age, came also the growing problem of pollution, in its various forms, environmental waste being possibly the greatest and most visible of all, while that of noise being, at least within the frame of human knowledge and experience, much less obvious a problem.

However, throughout the 20th century and with the introduction of heavy industry, within the ever-expanding industrial complex, accelerated greatly by the inexhaustible need for war material production, the problem of excessive noise, or what might be better referred to as industrial noise, has become one of the most common and detrimental pollutants of this century. Indeed, few people have not, at some point in their lives, been exposed to the bothersome and often harmful effects of noise, both psychologically and physiologically.

So great has the problem of industrial noise become, that government intervention has been evidenced in the form of protective legislation for the industrial worker, in both Canada and the United States. This legislation has established maximum noise level exposure limitations for industrial workers.

In the United States, this legislation has taken the form of the Williams-Steiger Occupational Safety and Health Act of 1970, which led

directly to the establishment of the Occupational Safety and Health Administration (OSHA) and of its offspring, the National Institute for Occupational Safety and Health (NIOSH). Both of these supervising agencies exist and operate within the United States Department of Health, Education and Welfare. Further, NIOSH has the responsibility of conducting research into the area of occupational health and safety standards and of passing on recommendations to the Department of Labor for legal enactment and enforcement (Olishifski & Harford, 1975, p. 9).

In 1974, OSHA limited maximum noise exposure for industry to a level of 90 dBA, or 90 decibels "A" weighted scale, for an eight hour period. The term "dBA" is explained in detail on page 6 of this chapter, and further in the following chapter of this report.

At that time, NIOSH indicated the need to reduce, still further, the maximum noise exposure level from 90 dBA to 85 dBA, for the same time period, but was unable to recommend a specific date when this level should be adopted for all industry.

The same criterion level of 85 dBA, for an exposure time of eight hours, has been adopted generally throughout Canada. In Alberta, this criterion was written into <u>Division 29 Regulations Respecting the Protection of Workers From the Effects of Noise</u> (1973), of the Provincial Board of Health (see p. 52). Since then, this set of Regulations in Alberta has been updated and is referred to as <u>The Occupational Health and Safety Act of 1976</u>, now under the authority of Alberta Labour. According to the Act of 1976, the 85 dBA level for an eight hour exposure is a maximum level/time exposure for steady-state noise. To date, no research dealing with noise levels in Alberta industrial arts laboratories, has been completed.

STATEMENT OF THE PROBLEM

The major problem of this investigation was to determine if the operational noise levels in the senior high, industrial arts laboratories of the Edmonton Public School Board conform to the 85 dBA standard of noise level, for an actual or equivalent exposure time of eight hours, as prescribed in the Regulations of The Alberta Occupational Health and Safety Act (1976).

SUBPROBLEMS

In addition to answering the problem basic to this study, three subproblems, concerning noise level/time exposures were identified. These subproblems were:

1. How do the various multiple activity areas in each laboratory compare with one another? In other words, how does the noise in the Materials Technology area compare with the noise in the Electronics Technology area, with the Power Technology area, and with the Visual Communications Technology area?
2. How do the noise levels in the similar multiple activity areas, in the different laboratories involved in the study, compare with one another? That is, how do the noise levels of all the Materials Technology areas compare with one another; all the Electronics Technology areas compare with one another; the Power Technology areas compare with one another; and the Visual Communications Technology areas compare with one another?
3. How do the eight hour average noise exposure levels for the

different school laboratories compare with one another? For instance, how did the eight hour average noise exposure level for McNally Composite High School compare with that of Harry Ainlay Composite High School; or with the noise exposure levels found in the industrial arts laboratories of Bonnie Doon, M. E. LaZerte, Strathcona, or Victoria Composite High Schools?

NEED AND SIGNIFICANCE FOR STUDY

Many of the educational activities carried on in industrial arts laboratories are used as a vehicle to teach machine/tool operations and manufacturing processes that, while on a much smaller scale, are similar to those actually carried out in industrial settings. Although these industrial arts activities can only be considered miniatures of actual industrial practices, they can produce noise that may be psychologically or physiologically damaging to those individuals who are exposed to such noise. Correspondingly, some industrial arts teachers, who teach in the multiple activity laboratories of Alberta, may have wondered at times, about the excessive noise levels that are generated within their laboratories by students working with tools and machines. Might those noise levels be potentially harmful to the hearing acuity of the teacher, who is often exposed to noise for extended periods of time? At present, this question has not been answered by any formal research nor does any data exist in the professional literature, that could provide an answer.

For many situations in industry, where noise levels may be high, such as in the automobile manufacturing industry, the aircraft industry or the heavy-duty equipment industry, the answer might be that level/time

noise exposures could be damaging to the worker who does not wear some form of hearing protection. Conversely, for industrial arts teachers who work in an environment, where noise is common to learning activities, no singularly definitive statement can be made. It would appear that a definite need does exist, to conduct an investigation to determine the relationship between the operational levels of noise exposure in industrial arts laboratories, and those noise levels established for industry. It is quite possible that an occupational health and safety hazard may exist in industrial arts laboratories, that teachers or administrators may not be aware of. Thus, if the noise level exposures are in excess of the standards established for industry, this information should be identified by systematic research. The significance of the data generated by such an investigation might be used by facility planners to assist them in designing industrial arts laboratories with lower noise levels in both new and renovated laboratories, or by those people who have the responsibility for writing new legislation, directed at occupational health and safety.

OPERATIONAL DEFINITIONS

The following are the operational definitions of the terms that will be used throughout this report.

Decibel (dB)

The decibel (dB) is the basic unit used by audiologists and acoustical engineers to make sound level measurements. Olishifski (1975) gives the following definition for the term decibel:

> a non-dimensional unit used to express sound levels. It is a logarithmic expression of the ratio of a measured quantity

> to a reference quantity. In audiometry, a level of 0 dB represents roughly the weakest sound that can be heard by a young person with good hearing. (p. 1028)

dBA

All measurements relating to noise measurement and hearing are made in the "dBA" mode. This notation refers to a sound level reading made on the "A" weighted network of a sound measurement device. Olishifski (1975), defines the "A" weighting network as:

> an electronic network that weights various frequencies approximately in accordance with the response of the human ear, which is non-linear. (pp. 1028-1062)

This definition is interpreted to mean that the human ear is characterized by less sensitivity to the lower frequencies below 500 Hz (hertz) (or 500 cycles per second) and to the higher frequencies above the 6 000 to 8 000 Hz (or cycles per second) range.

Dosimeter

Olishifski (1975) defines the noise dosimeter as "a device worn on the person for determining the accumulated sound exposure with regard to level and time (p. 1031)". The dosimeter is an electronic device used in this study to measure noise level exposures in the industrial arts laboratories that comprised the population of this study.

Industrial Arts

Industrial arts is an evolutionary term that has as many definitions as there are writers on this topic. The Handbook of Industrial Education, 1976, a publication of Alberta Education, defines industrial arts as:

> the exploratory phase of the continuum (that) provides the opportunity for the students to explore, reason, experiment,

> and discover the reality of the technological society in which they live. The content of the program deals with industry, its organization, materials, processes, products, occupations, and the problems resulting from the impact of technology on society. (p. 2)

The definition given by Feirer and Lindbeck (1969) is the one that was selected for this study because of its close relationship to the definition given for industrial arts by Alberta Education. These authors define industrial arts as:

> the broad study of the tools, materials, equipment, processes, products, and occupations of industry, pursued for general education purposes in the shops and laboratories of schools. (p. 15)

Multiple Activity Laboratory

The 1976 Junior High Industrial Education Guide, an official publication of Alberta Education, defines a multiple activity laboratory as a laboratory where "there are three or more activities in progress at the same time." (p. 3) The Guide (1976), goes on to name those activities as: Power Technology, Materials Technology, Visual Communications Technology (Graphics), and Synthesizing. (pp. 3-5)

For the purpose of this study, the term "industrial arts laboratory" will be used as a synonym for the term "multiple activity laboratory".

Noise

Noise is a term that can be, and has been, given various definitions by different authors. Despite these variations, most definitions share in common the particular characteristic that what is classified as noise will ultimately depend on the individual's perception and circumstance. Olishifski (1975) defines noise as "any unwanted

disturbance" (p. 1043). Applying this definition to the learning activities conducted in a multiple activity laboratory, noise can be defined as any unwanted or undesirable sounds, generated by the machinery, machine-tool operations and manufacturing processes, carried out in the industrial arts laboratory.

Noise Exposure

Noise exposure is defined by Olishifski (1975) as being "the total acoustic stimulus applied to the ear over a period of time" (p. 1043). Operationally, and within the context of the multiple activity laboratories involved in this study, noise exposure was the totality of noise that teachers were exposed to, in the course of their normal, day to day, occupational environment and the instructional activities carried out in that environment. Generally, that exposure involved anywhere from four to five hours per day in the industrial arts laboratory and was based on a 200 day school year.

Senior High School

The Alberta Education publication entitled, Handbook in Industrial Education (1976), defines senior high schools as comprising grades 10, 11 and 12. (p. 10)

POPULATION

The population for this study included all of the senior high school, industrial arts laboratories of the Edmonton Public School Board that offered a program of study in industrial arts, based on the curriculum guides published by Alberta Education.

Of the seven laboratories that made up the population of this

study, there was one, single teacher laboratory (Victoria Composite); one, two-teacher laboratory (Harry Ainlay Composite); one, three-teacher laboratory (Strathcona Composite); two, four-teacher laboratories (McNally Composite and Bonnie Doon Composite); one, five-teacher laboratory (Queen Elizabeth Composite); and one, six-teacher laboratory (M. E. LaZerte). In all seven laboratories, there was a total of 25 industrial arts teachers.

INSTRUMENTATION

An electronic measuring device known as a noise dosimeter was used to record noise exposure readings in each laboratory that was involved in providing data for analysis.

The major reason for having selected a noise dosimeter was that a field agent of the Alberta Occupational Hygiene Branch, Alberta Labour (the branch responsible for enforcing the Regulations of The Occupational Health and Safety Act) recommended that this type of instrument be used. The reason for having made this recommendation was that noise in industrial arts laboratories, is not constant either to frequency or duration, but rather, can be highly variable in both of these dimensions. The noise dosimeter can add up or accumulate noise exposure, taking into account both intensity and duration.

Two dosimeters with different trade names were used in the research because two instruments by the same manufacturer were not readily available.

The instruments used in the study were a General Radio, Type 1944, and a Bruel and Kjaer, Model 4425. The General Radio dosimeter consists of two separate units; a noise exposure monitor and an

indicator unit. The Bruel and Kjaer dosimeter is a one piece unit with an external microphone connected via a preamplifier cable.

In both cases, the noise dosimeters were worn in the breast pockets of the laboratory jackets, so that the microphones would be as close to the ear as possible; thus ensuring a realistic noise level pick-up by the microphone. In the case of the Bruel and Kjaer having an external microphone, this was clipped onto the lapel of the teacher's laboratory jacket, thus being within close proximity of the ear of the user.

Both noise dosimeters operated in the same manner. The unit, after being activated by a switch, continuously accumulates noise exposure in the environment where it is being used. At the end of the use period the dosimeter is switched off. The operator, by depressing a "read" button, activates a light-emitting diode display that shows the percentage of permissible noise exposure at 85 dBA for an eight hour period. Any percentage over 100 would indicate a violation of the 85 dBA for an eight hour exposure standard and anything less would indicate a non-violation. For time periods less than a full eight hours, an accurate projection for an eight hour equivalent can be made by using the following conversion formula:

$$\frac{8}{B} \times A = 8 \text{ hour equivalent}$$

where B represents the number of hours of exposure and A represents the percentage readout given by the noise dosimeter unit. Both dosimeters feature a warning indicator lamp that lights if the noise level exceeds 115 dBA at any time during the measurement period. That reference level proved useful by way of indicating noise levels at, or beyond, the

115 dBA level of intensity.

Reliability and Validity of the Instrument

The noise dosimeter is used by professional industrial audiologists, acoustical engineers and field agents in occupational hygiene to measure noise level exposures in a variety of settings. These instruments must meet certain government specifications prior to being certified as capable of producing accurate and reliable acoustic measurements. The noise dosimeters used in this study do meet and conform to the standards established by both the Canadian Standards Association (CSA - Z 107.1 - 1973) and the American National Standards Institute (ANSI S1.4 1971) specification for a Type 2 Sound Level Meter.

In order to guarantee the total accuracy of a noise dosimeter, the instrument must be calibrated before and after use in a test situation. In the case of the units used in this study, calibration with the General Radio dosimeter was an automatic and daily condition of use, as the calibrator was built into the instrument. The Occupational Hygiene Branch, Alberta Labour, calibrated the Bruel and Kjaer noise dosimeter prior to its use in the study, half way through the research, and at the culmination of the study.

PROCEDURE AND DATA COLLECTION

The procedures involved in conducting this study required a number of interrelated steps. The Occupational Hygiene Branch, Alberta Labour, was contacted by telephone for the following purposes: to discuss the research, to obtain information to determine what the provincial regulations were on the permissible noise exposures for industry,

and also the type of instrumentation that is professionally used to measure noise in an industrial setting.

Personnel of the Occupational Hygiene Branch were extremely cooperative in providing the requested information. In addition, they mailed to the researcher, a number of articles on noise and noise measurement, as well as a copy of The Alberta Occupational Health and Safety Act (1976). It was recommended by these personnel that the noise dosimeter be used to make noise exposure measurements and that contact be made with the Department of Mechanical Engineering at The University of Alberta, to determine the possibility of securing a noise dosimeter for use in the research.

Telephone contact was made with the Department of Mechanical Engineering and it was found that a noise dosimeter was available - the General Radio, Type 1944, and that the unit could be used by the researcher for the duration of the investigation.

A second noise dosimeter, used in the research, was a Bruel and Kjaer, Model 4425, and was secured from the Occupational Hygiene Branch, Alberta Labour. With the use of this additional instrument the research time was reduced by half because the noise levels in two schools could be monitored simultaneously.

To secure permission to conduct the research in the schools that made up the population of the study, a Cooperative Activities Form was completed and routed through the Division of Field Experiences, Faculty of Education, The University of Alberta, to the Director of Research, Edmonton Public School Board. The Director of Research, after receiving the form, forwarded it to the appropriate school administration for

review and approval. Subsequently, a letter of approval to conduct the study was received by the researcher from the Director of Research. A copy of that letter can be found in Appendix B, p. 113.

Following receipt of the letter of approval, the researcher contacted by telephone, the principal and the industrial arts staff of each of the seven participating high schools. That contact was made in order to establish a schedule of visits, when the researcher could enter the schools and arrange for the monitoring of the noise exposure levels for each of the industrial arts laboratories involved in the study. In addition, one industrial arts teacher, in each school, was asked to act as a liaison person with the researcher.

The liaison person was responsible for the daily operation of the noise dosimeter, for supervising the daily rotation of the unit between teachers, and for the recording of noise exposure data from the dosimeter onto the "Noise Exposure Survey Data Sheet" that was provided to each of the schools. These telephone contacts were then followed up with a formal letter which was sent to each industrial arts liaison person at each of the seven participating schools to confirm the times and dates that site visits would be made by the researcher. Appendix E, p. 121, includes a copy of that correspondence.

Following the prescribed schedule of visits (see Appendix D), each industrial arts laboratory in the seven participating schools was monitored and the necessary data collected. Appendix A, p. 105, illustrates the form that was used to record data that were collected. At the end of each day the liaison person entered the data that were required on the "Noise Exposure Survey Data Sheet" which included: the

day, the area of the laboratory that was monitored, whether or not hearing protection was used by either the students or the teachers working in that area, the percentage noise exposure readout (taken from the noise dosimeter at the end of each day), the elapsed time exposure in hours (to the nearest quarter hour), and whether or not the 115 dBA exceeded lamp had been activated. The remaining information, regarding the percentage for the eight hour equivalent noise exposure and the eight hour laboratory average, were computed and recorded on the data sheet, by the researcher.

Both the noise dosimeter and the data sheets were delivered on a Friday afternoon to the first schools listed on the research schedule. At the time that the instruments were delivered to the schools, the researcher met with the liaison person in each school and demonstrated the correct procedures used to operate the noise dosimeter and the method used to record data. The following Monday morning was the start of the research cycle for the first two participating schools. In each of these schools, the liaison teacher wore the noise dosimeter on the first day and recorded the collected data on the form that was provided to each school. On subsequent days, dosimeters that were placed in each of the industrial arts laboratories, were rotated on a daily basis from one area teacher to another, until the dosimeter had been used to measure noise levels in each of the areas of the laboratory.

In an industrial arts laboratory that had more than or less than five teachers, the noise dosimeter was rotated randomly among those teachers for the balance of the week. This rotation was at the discretion of the industrial arts liaison person, and where any technology

area was monitored on two or more occasions, the higher percentage figure was chosen as being the most representative figure for data analysis considerations.

In the case of a single teacher laboratory, that teacher acted as the liaison person and wore the noise dosimeter unit every day, recording the required data on the "Noise Exposure Survey Data Sheet" at the end of each day. In that case, the percentage chosen for data analysis was based on the average daily exposure recorded on the noise dosimeter.

Because the equipment was transferred from one school to the next on every Friday afternoon, only readings for four full days (Monday through Thursday) and one-half day (Friday morning) were taken for each week. In all cases, data for each day were extrapolated to an eight hour equivalent since the elapsed time exposure for any school day was always less than eight hours.

ANALYSIS OF DATA

After all of the data were collected in each of the seven participating schools, a detailed analysis was made of the data that were collected and recorded on the "Noise Exposure Survey Data Sheet".

For ease of interpretation the collected data were placed into tabular form with a percent given for each school and area in the industrial arts laboratory. The criterion that was established for determining a percentage was the limitation for noise exposure level of 85 dBA for an eight hour period.

PILOT STUDY

Prior to conducting the major study, a pilot study was initiated at one of the schools that formed part of the population of this research. This school was selected because of the limited number of schools that was available.

The pilot study phase of the research had the following purposes:

- for the researcher to become familiar with the operation and use of the noise dosimeter to measure noise exposure levels;
- to determine if the procedures of the research design were properly sequenced; and
- to determine whether or not the noise levels in the pilot school were below the acceptable noise exposure level of 85 dBA for eight hours, the level for industrial noise established by The Alberta Occupational Health and Safety Act (1976).

After permission had been granted by the Edmonton Public School Board to involve its high schools in the study, the researcher telephoned the industrial arts staff of the pilot school to arrange for a time when the researcher could meet with the industrial arts staff to discuss the purpose of the study.

A site visit was made by the researcher to the pilot school on a Friday afternoon prior to the week that the pilot study was actually conducted. During the visit, the purpose of the study and the research methodology were described in detail; the use and operation of the noise dosimeter was explained and demonstrated; the procedures used in filling out the relevant parts of the "Noise Exposure Survey Data Sheet" were

explained; and the role of the industrial arts staff in the pilot school was discussed. In addition, the researcher solicited the aid of a volunteer, industrial arts liaison person, to assist in the collection of the data for the research.

During the next four and one-half days, the following areas in the pilot school were monitored: the Materials Technology area, the Electronics Technology area, the Power Technology area, and the Visual Communications (Graphics) area.

Results of the Pilot Study

Data generated from this stage of the research indicate that for the eight hour equivalent, the following percentages, of the 85 dBA exposure level, were obtained: Materials Technology - 74.6 percent; Power Technology - 10.6 percent; Electronics Technology and Visual Communications Technology - both at 0 percent. The eight hour noise exposure, laboratory average, for the 85 dBA level, based on those figures, was 23.0 percent.

On two occasions, the 115 dBA lamp was activated; once in the Power Technology area and once in the Materials Technology area.

These results indicate that the noise exposure levels in the Electronics and Visual Communications areas, as well as in the Power Technology area, appear to be fairly innocuous and safe, especially when one considers the fact that the industrial arts teachers involved in the pilot study reported normal operating conditions for the week that the research was conducted. All teachers felt that the noise levels for that week were representative of the normal noise environment.

The result of 74.6 percent for the Materials Technology area,

plus the fact that the 115 dBA level was exceeded, supports the supposition that a potential hearing hazard may indeed exist in that area.

Interpretation of the fact that the 115 dBA lamp was activated in the Power Technology area, indicating that noise levels at least equalled, or possibly even exceeded the 115 dBA level of intensity, is not quite so clear, especially when one considers the noise exposure reading of only 10.6 percent for the 85 dBA for eight hour standard. Quite possibly, the hazard in that particular area lies not so much in terms of noise time exposure, but rather with regard to very high levels of intensity which certainly, depending on time and level, could be hazardous to a person's hearing.

Lastly, the 23.0 percent noise exposure, laboratory average for an eight hour period, means very little without any other schools with which to compare.

ORGANIZATION OF THE THESIS

This chapter has presented an introduction to the research and a statement of the problem and subproblems related to that research. Also included in the content of the chapter are: the operational definitions that were used throughout the study; a description of the population of the study, and of the instruments that were used to collect data; the methodology that was employed in collecting data for analysis; the analysis of these data; and finally, the pilot study that preceded the major research, is explained.

The second chapter presents a review of the related literature and the findings of previous research investigations that were conducted

in educational settings and that have direct implications for and bearing on this study. Also forming an integral part of the second chapter is an explanation of the physical characteristics of noise and measurement of sound. The function and physiology of the human hearing mechanism is described and the current health and safety standards for noise in industry, also form part of the content of chapter two. The chapter concludes with a description of an Alberta multiple activity laboratory and the capital equipment, in that learning environment, capable of generating noise.

The third chapter presents the findings of the study and in addition to a discussion of those findings, includes a physical description of each of the seven laboratories; of the capital equipment found in those laboratories; and of the amount of time that is spent by the industrial arts teachers in each of those laboratories.

The fourth and last chapter summarizes the study, its findings, and the recommendations that were generated by the data that were collected and analyzed.

Chapter 2

REVIEW OF THE LITERATURE AND RELATED RESEARCH

Introduction

This chapter includes the findings of a number of research reports that were identified through a library search and that have relevance and bearing on the topic of this research investigation. Other sections of this chapter include: the physical characteristics and the measurement of sound; the function and physiology of the human hearing mechanism; the effects of noise on hearing; and the current health and safety standards for industry in Alberta. In addition, and as part of the content of this chapter, is a description of an Alberta multiple activity laboratory and of the major pieces of capital equipment, contained in such a learning environment, that may be noise generating.

THE LIBRARY SEARCH

The Special Collections of the Cameron Library houses a card catalogue that lists all theses completed at The University of Alberta. A manual search of that collection revealed that no research, related to this study, had been completed.

The 1977 edition of the Thesaurus of ERIC Descriptors (ERIC meaning Education Resource Information Center), includes 17 key words or descriptors, that could be used to identify related research that had been completed. Those were: Acoustics, Acoustical Environment, Audition, Ears, Environment, Environmental Influences, Hearing, Hearing

Conservation, Hearing Loss, Industry, Industrial Arts, Industrial Education, Pollution, School Environment, School Shops, Sonic Environment, and Sound Effects.

These descriptors were used to conduct a manual search of the literature which dated from 1969 to 1978. The results of that search indicated that very little had been written on the subject of noise levels in an industrial arts shop or laboratory.

The Education Index, the Canadian Education Index, and the Current Index to Journals in Education were also reviewed to identify journal articles written, that might have implications for this study. The result of that review was that very little had been written in professional journals that was related to the topic of this investigation.

The Journal of Speech and Hearing Disorders and the Journal of Speech and Hearing Research did include articles that were considered to be peripherally related to this study.

Also, a number of articles related to this study were listed in the Canadian Periodical Index. From a thorough review of that index it was found that the majority of those articles had been written in the past decade.

THE COMPUTER SEARCH

Initially, an "on line" computer search was planned in order to identify reference materials that could be reviewed as related literature. In discussing such a search with a resource librarian of the Cameron Library, the recommendation was made that a manual search first be made of the ERIC descriptors to determine whether or not a sufficient data base existed. It was pointed out that without such a data base, an

"on line" computer search would be a waste of money. After conducting the manual search, it was found that a data base did not exist; this negated the need for a computer search.

SEARCH OF DISSERTATION ABSTRACTS

A manual search was made of the dissertation abstracts published by the National Association of Industrial, Technical, Teacher Educators (NAITTE) to identify doctoral research that has been conducted and that was related to this investigation. From this search four doctoral dissertations were identified that had been completed at American universities and that are related to this study.

Hicks (1973), completed research for a doctoral dissertation at Utah State University, which dealt with "Noise Pollution as a Potential Safety and Health Hazard Within Selected Utah Industrial Education Laboratory Facilities". The purpose of that research was to investigate the existing noise levels, in both woodworking and metalworking industrial education laboratories, to see whether or not the noise levels in those facilities complied with the American standards for industrial safety. The population for this study included a random sample of 30 different industrial education laboratories in the State of Utah. The major conclusions of that investigation were:

1. that a potential safety and health hazard existed with noise levels within those industrial arts education facilities;
2. that many members of the profession were not fully informed about legislative safety and health standards;
3. that the din of noise produced around machinery must not be considered a problem relevant only to industry and that the

> usage of machinery in educational settings places the same potential for occupational hearing impairment into the educational laboratory (Abstract).

Pontynen (1973), completed research toward a doctoral degree at Arizona State University. That research was concerned with "An Evaluation of Noise Levels in College Welding Laboratories and Its Effect on Student Hearing". The study was confined to a sample of selected welding laboratories found in the community and senior colleges of northern California. The major purposes of that study were to establish what levels of noise existed in those laboratories, and to determine if those noise levels had any effect on the hearing acuity of students taking the course. One of the major findings of that investigation was that by "exposing students to sound pressure levels above 90 dBA . . . some school welding laboratories are exposing students to ambient noise conditions which are of definite concern" (Abstract).

Monfette (1974), for doctoral work completed at Wayne State University, Detroit, conducted research that terminated in a dissertation entitled, "Survey of Sound Levels in Selected School Laboratories to Determine Compliance With Provisions in the Occupational Safety and Health Act of 1970" (OSHA). The purpose of that investigation was to determine whether or not any of the 12 participating vocational education, school shops were in violation of the American standards for industrial safety. The findings of that study revealed:

1. that two of the laboratory programs were in violation of those standards; these two programs were welding and cutting, and aircraft maintenance;
2. that several other areas; carpentry, autobody, mechanics

and diesel, had levels very close to the federal limit, for noise levels, set by OSHA;

3. that other areas: small engines, millwork and cabinetmaking, and sheet metal, were of very definite concern; and
4. that sound levels averaged a high of 82 dBA "which is a level detrimental to human hearing if exposure continued for more than a few years" (pp. 160-161).

Another doctoral study was identified that was considered to be tangentially related to the current study. Rost (1974), completed an investigation at Purdue University that was entitled, "A Study Determining the Effects on Teacher-Student Interaction When Wearing Hearing Protectors As An Abatement Device for Noise Control". Rost found that the wearing of hearing protectors "did not significantaly alter or affect the amount of communication between a teacher and his students" (Abstract).

THE PHYSICAL CHARACTERISTICS OF SOUND

Any study of noise must necessarily also be a study of sound, for noise is, first and foremost, sound. The literature on sound tends to accommodate two different, but related definitions for the term "sound".

The Industrial Noise Manual (1966), approaches this definition from an objective point of view and defines sound as "pressure alterations or particle displacements propagated in an elastic medium" (p. 1). Burns (1973), in his book Noise and Man, gave a subjective definition for the term sound when he wrote that sound was "the sensation of hearing excited by mechanical disturbance" (p. 11).

Olishifski (1975), expanded the definition of the term sound,

given in Industrial Noise and Hearing Conservation, when he described sound as:

> a wave motion, due to pressure alteration or particle displacement in an elastic medium . . . (which produces under normal cirstances, brackets mine) a sensory experience in the brain (p. 30).

Because of the inclusiveness of the definition by Olishifski to include a comprehensive view of sound as not only a physical, but a sensory experience, that definition will be the one used throughout this report.

The Nature of Sound

Sound is a form of energy which causes variations within the normal atmospheric pressure (Industrial Noise Manual, 1975, p. 1). Normal atmospheric pressure is defined in terms of air pressure at sea level, which was traditionally measured at 14.7 pounds per square inch, or its Systeme International (SI) equivalent of 100 000 N/m^2 (newtons per square metre) (Olishifski, 1975, p. 50). It should be noted that this is the pressure incident upon the earth at sea level and is, therefore, considered the standard for atmospheric pressure (Olishifski, 1975, p. 50).

These so called variations within the atmospheric pressure, occur in the form of deviations beyond what has been described as normal atmospheric pressure and can be explained in terms of compression and expansion (or rarefaction) (Sataloff, 1966, p. 269). These terms refer to the volumetric density of the molecules within the air. Compression refers to a compressed state, wherein the number of molecules in a given volume of air is greater than normal. Expansion refers to an expanded state, wherein the number of molecules in a given volume of air is less than normal. Each combination of compression and expansion is known as

one complete cycle, with successive cycles forming sound waves, as shown in Figures 1 and 2 (Sataloff, 1966, p. 269).

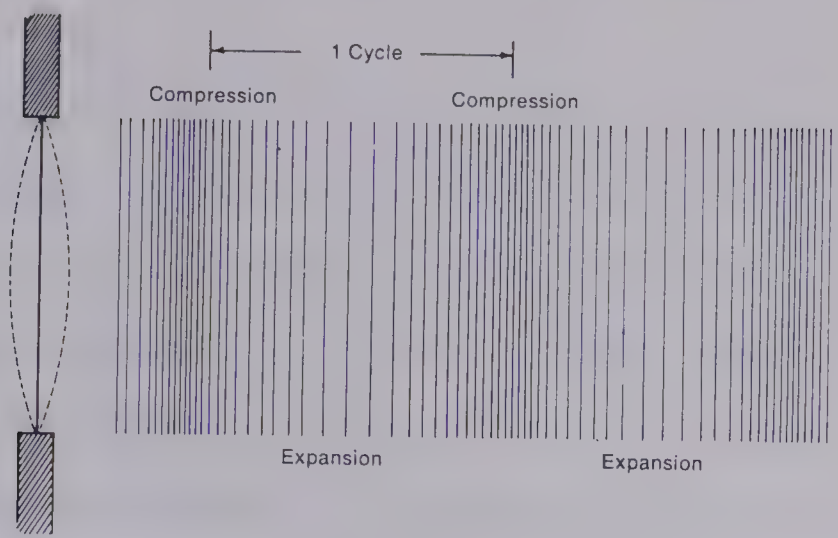


Figure 1. A plane sound wave showing alternating cycles of compression and expansion. (Taken from Industrial Noise and Hearing Conservation, p. 42).

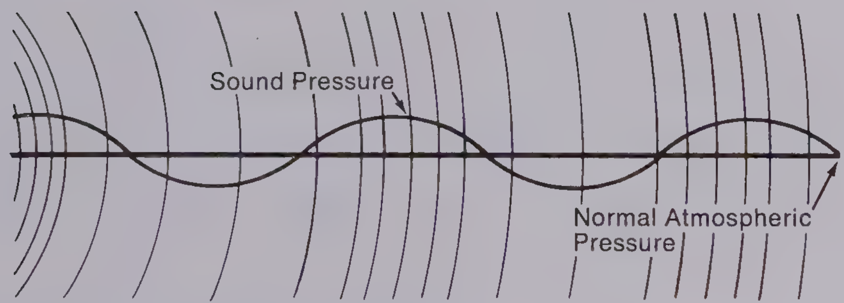


Figure 2. Air is an elastic medium and behaves as if it were a succession of adjoining particles. The resulting motion of the medium is known as wave motion and the instantaneous form of the disturbance is called a sound wave. (Taken from Industrial Noise and Hearing Conservation, p. 41).

The Medium and the Speed of Sound

Since sound involves the transfer of energy by way of wave motion or particle displacement, it becomes apparent that sound requires

a medium for its propagation. Whatever affects the density of the medium, such as temperature or in the case of gases, air pressure; will also affect the speed of propagation of sound (Olishifski, 1975, pp. 46-47).

Generally as the density of the molecules in a given volume of the medium increases, the speed of propagation of sound also increases. To illustrate: in air sound travels at only 344 m/s (meters per second). However, this rate increases to 1433 m/s in water, 3962 m/s in wood, and 5179 m/s in steel (Olishifski, 1975, p. 47).

As temperature increases, the molecular density of the air decreases and accordingly, the speed of propagation of sound also decreases. Conversely, as temperature decreases, the molecular density of the air increases; in effect the air becomes more compact, and the speed of propagation of sound increases.

Regarding air pressure, as the elevation above sea level increases, the air rarefies and becomes less dense. As a result, the propagation of sound (i.e. the displacement of molecules) is conducted at a slower rate. In short, sound speed decreases as altitude increases.

The Frequency and Range of Human Hearing

The number of complete cycles of compression and expansion that occur in a given time determine the frequency of the sound wave. For example, a sound wave characterized by 125 cycles over a period of one second, would be said to have a frequency of 125 Hz (*Industrial Noise Manual*, 1975, p. 1).

The simplest type of sound is a pure tone which is sound of a single frequency. Most sound in the human sonic environment ideally

spans the range from 20 to 20 000 Hz and very seldom involves a pure tone by itself (Olishifski, 1975, p. 46). Most sounds are complex tones that involve a combination of different frequencies.

THE MEASUREMENT OF SOUND

The Need for a Reference Pressure

Until recently no reference pressure existed for the human ear for quantitatively measuring the pressure variations produced by environmental sounds, at variance with normal atmospheric pressure. The question arises "how much pressure variation can the human ear accommodate?" Generally, those limits encompass the range from 0.00002 to 20.0 N/m^2; from the very threshold of hearing where audibility just begins, to the threshold of feeling where sound produces physical sensation, and if intense enough, pain (Olishifski, 1975, pp. 50-51). These limits are shown in Figure 3.

Of significance is the establishment of a reference level at 0.00002 N/m^2 (or 0.0002 microbars), which is internationally recognized as being the threshold of hearing for young adults with good hearing. That level is also the standard across Canada and is the one used by the Alberta Occupational Hygiene Branch when making sound level measurements.

The Decibel (dB) Scale

Olishifski (1975) points out that the range of 0.00002 to 20.0 N/m^2 represents a ratio of 1 to 10 000 000 and to construct a linear scale to span that range, would be analogous to creating a scale that would range from one inch to 16,000 miles, and to use that scale to measure both inches and miles (p. 51).

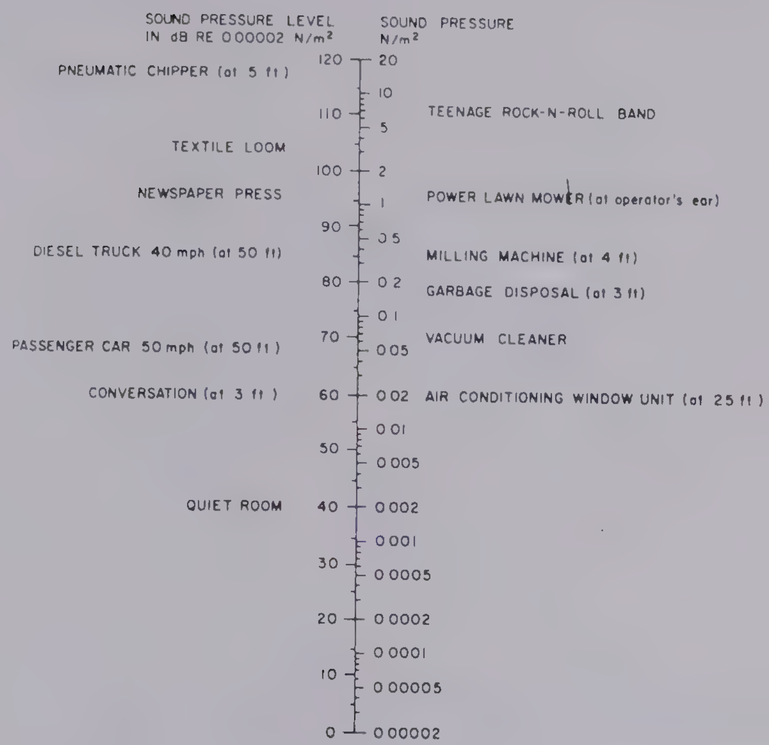


Figure 3. The relationship between "A" weighted sound pressure levels and decibels (dB) and sound pressure in N/m^2. (Taken from Industrial Noise and Hearing Conservation, p. 51).

Since any linear scale is impractical for measuring sound pressure levels, the decibel scale, which is a logarithmic scale, was selected. As a result, the fields of acoustical engineering and audiology use the decibel scale to measure sound pressure level.

The threshold of hearing, which is a sound pressure level of 0.00002 N/m^2, coincides with 0 dB on the decibel scale. A level of 10 dB would mean a level that was 10 times louder than the threshold of hearing. A level of 20 dB would represent a level that was 100 times louder than the threshold of hearing; 30 dB, a 1 000 times louder; 40 dB, 10 000 times louder; 50 dB, 100 000 times louder, and so on. The maximum sound pressure level that the ear can sense is about 140 dB and that level far exceeds the threshold of pain which is just reached, but

greatly increases after 120 dB (Olishifski, 1975, p. 52). Some typical overall sound pressure levels are shown in Figure 4.

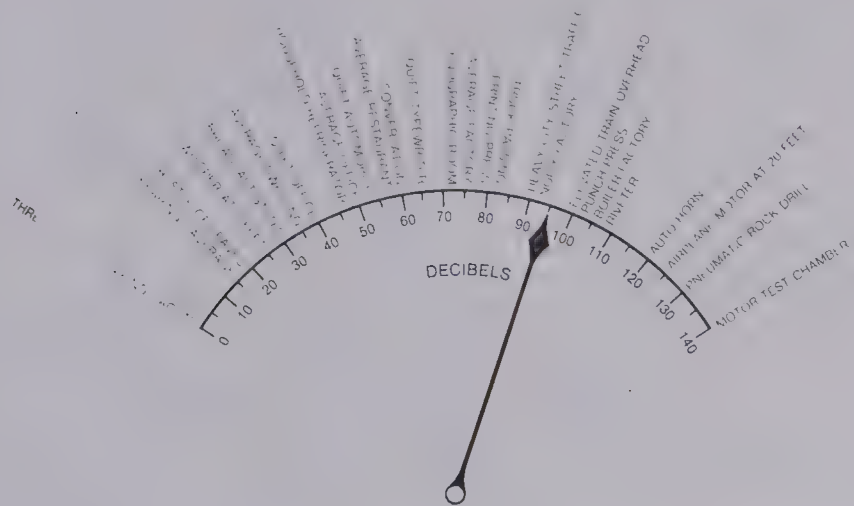


Figure 4. Typical sound levels associated with various activities. (Taken from Industrial Noise and Hearing Conservation, p. 53).

Because the decibel scale is logarithmic, decibels can neither be added or subtracted arithmetically. For instance, adding two differing sound pressure levels of 70 dBA and 76 dBA would not equal 146 dBA. Rather the resulting sound pressure level would only be slightly greater than the loudest of the two sounds (i.e. 77 dB) (Sataloff, 1966, pp. 276-277).

Measuring Sound With the Sound Level Meter

The basic instrument for the measurement of sound is the sound level meter (SLM). Essentially, the SLM is a portable electronic device consisting of a non-directional microphone, an attenuator, an amplifier, and an indicating meter and is used to measure the weighted overall sound pressure level, in decibels, relative to the standard reference level of 0.00002 N/m^2 (or 0.0002 microbars) (Olishifski, 1975, pp. 107-113).

Sound level meters must meet stringent national and international standards and are classified by the following standards writing bodies: the Canadian Standards Association (CSA), the American National Standards Institute (ANSI), and the International Standards Organization (ISO), as either Type 1 Precision, Type 2 General, Type 3 Survey, or Type S Special Purpose (Olishifski, 1975, pp. 108-109).

Generally, the SLM will measure within a range of 40 to 140 dB, in either a slow response or fast response mode, and in any of the following: A, B, or C electronic weighting networks.

For purposes of noise measurement, the slow response mode is preferred and is the federally required mode of operation. This mode gives an average reading of the sound pressure levels being recorded.

The electronic weighting networks A, B, and C serve a number of different purposes, and again, each network must conform to stringent standards of operation as established by the formal standards writing organizations (CSA - Z 107.1 1973 and ANSI S 1.4 - 1971). The "A" mode, which is the officially specified and audiologically preferred mode, reacts to and measures sound pressure levels in a manner that closely approximates that of the human ear's response to sound. Figure 5 shows the frequency response characteristics of the A, B, and C weighting networks of a typical sound level meter.

The human ear does not react to sound pressure levels in a linear manner, but rather, is most sensitive to those sounds within the speech range of 250 to 4 000 Hz and especially to those sounds within the middle frequency range of 1 000 to 3 000 Hz. This is shown in Figure 6.

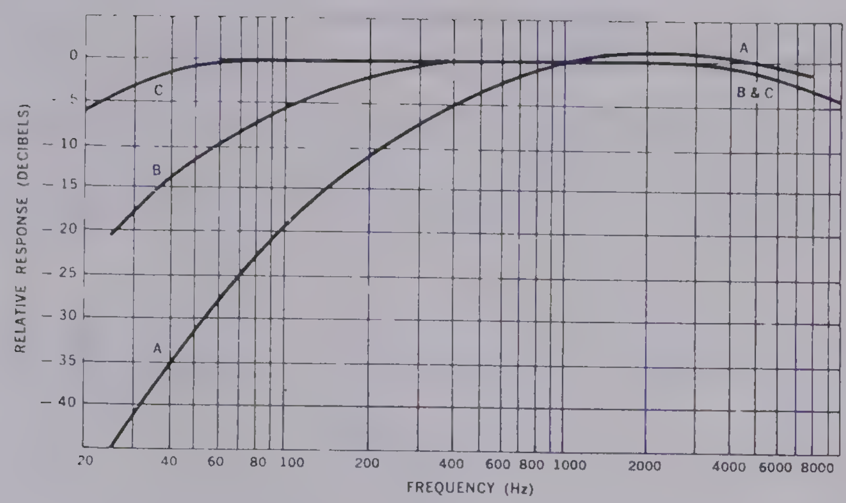


Figure 5. The frequency response characteristics of a sound level meter with A, B, and C weighting networks. (Taken from Industrial Noise and Hearing Conservation, p. 111).

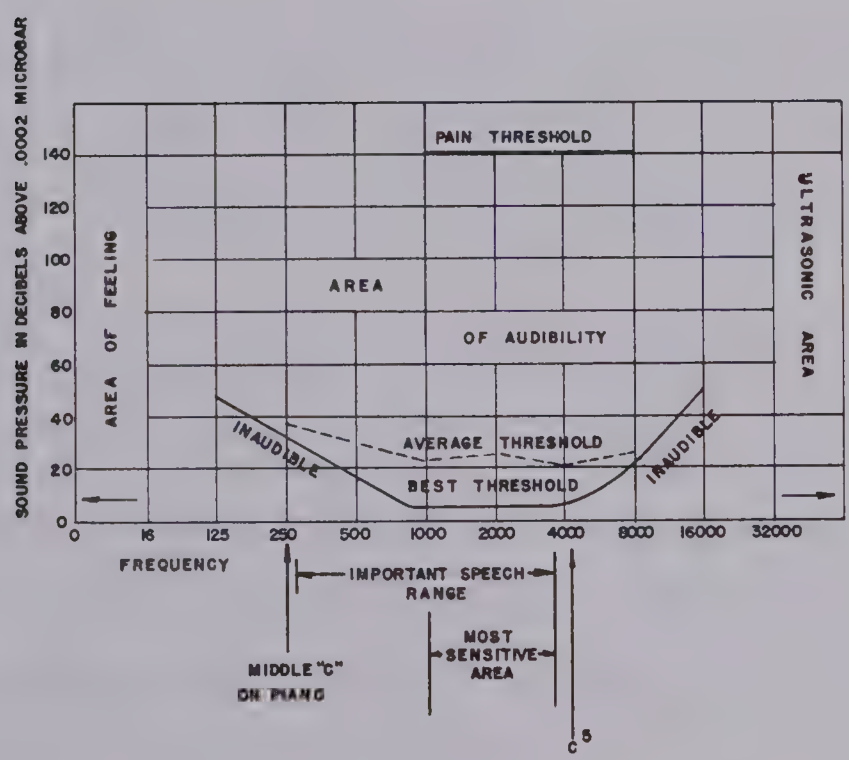


Figure 6. The area of audibility and sensitivity of the human ear. (Used with permission. Copyright 1966 by J. B. Lippincott Co. Taken from Hearing Loss by J. Sataloff, p. 280).

SLM Sophistication

Within the last decade advances in electronics technology have

permitted the greater sophistication and specificity of the equipment used to measure sound. Because of this technology, the basic sound level meter has developed into the frequency analyzer; the impact-noise analyzer; the graphic level recorder, and the noise exposure monitor or dosimeter.

The frequency analyzer is a specialized SLM which analyzes sound according to frequency, by measuring sound pressure levels at different frequencies. Generally the octave bands of 31.5, 63, 125, 250, 500, 1 000, 2 000, 4 000, 8 000 and 16 000 Hz can be used, for example, to graph a noise "picture" of a table saw in operation. This graph will reveal at what particular frequencies most of the noise, made by the saw, is coming from.

The impact-noise analyzer which has an extremely fast response time, can accurately measure sound pressure levels of extremely short duration, such as a rifle report, the impact of a hammer striking an anvil, and so forth.

The graphic level recorder produces a permanent graphic presentation of the sound pressure levels over any period of time. When used in conjunction with a frequency analyzer, a comprehensive and permanent frequency analysis of the noise picture can be made. Such a unit could be installed virtually anywhere and could be used in an unmanned, remote fashion to record the noise characteristics.

The noise exposure monitor or the noise dosimeter is the measuring device suited for situations that are sonically intermittent and haphazard. This unit accumulates the totality of the noise exposure for any period of time (usually under eight hours). At the end of the use period the noise dosimeter provides a digital readout in the form of

percentage exposure to a particular point of reference, such as 85 dBA, slow response. With this unit it is fairly simple to determine whether or not the noise in a particular environment is in violation of a certain time/level exposure.

A Definition of Noise

Noise can be defined as any undesired or unwanted sound. The racket produced by a pneumatic hammer, the roar of a jet, the screeching of automobile tires, the buzzing of a fly, even the melody of a popular symphony, under certain circumstances each could be conceived as "noise" by the listener. The classification of what is noise and what is not noise, can very often be reduced to a value judgment on the part of the individual receiving the sound. An appreciation of "rock" music might be used as an example. There are many young adults and teenagers who really enjoy this type of music while at the other end of the continuum there are those who consider rock music as offensive and "noise". The definition of noise depends on the point of view of the listener and the circumstances under which the noise is perceived.

Types of Noise

According to Bell (1973) in industrial settings there are three basic and distinct types of noise: discrete frequency, broadband and impulsive-impact noise (section 3.1).

Discrete frequency noise is pure tone or single frequency noise generated by rotating equipment such as fans, rotary blowers, compressors, pumps, internal combustion engines, gears, transformers, etc.

Broadband noise is characterized by the rumble or hiss of high velocity gases, steam, shop air, etc.

Impulsive-impact noise is sound of extremely short duration such as an impact, a hand clap, a rifle report, a punch press, a stamping machine, hammering, etc.

Noise can also be described in terms of time duration as being either steady-state noise or intermittent noise. For example, the noise produced by the operation of a V-8 engine would be basically steady-state noise, whereas the noise produced by the normal operation of a rivet gun would be classed as intermittent noise.

Noise in the Industrial Arts Laboratory

The noise normally produced in industrial arts laboratories is of the intermittent type, with the majority of that noise being associated with discrete frequency and impulsive-impact noise. Noise produced by the blower and exhaust system in a laboratory; that produced by an internal combustion engine, circular saws, radial arm saws, planers, shapers, milling machines, and all other sorts of rotary machines would be classified as discrete frequency noise. That noise produced by a rivet gun, hammering, a stamping press, an offset press in operation, and so forth, represents impulse-impact noise. Examples of broadband noise in industrial arts laboratories would be pneumatically operated devices, such as those found in the plastics area, or in power, gas welding and steam operated devices.

THE FUNCTION AND PHYSIOLOGY OF HEARING MECHANISM

Since all sound, and noise, is perceived by means of the hearing mechanism, and since in many cases this mechanism can be damaged by intense sound or by extreme time exposure to sound, or by a combination

of the two, a study of hearing function and physiology is desirable.

The human hearing mechanism, used to receive and "hear" sound, can be viewed as consisting of four spearate, but interrelated parts: the outer, the middle, the inner and the neural ear. This hearing mechanism can also be viewed as a transducer of energy, which allows us to "hear". Acoustical energy is channeled into the ear via the outer ear, where it is converted into mechanical energy in the middle ear, thence to the hydraulic energy in the inner ear, and finally, to electrical energy in the neural ear. Figure 7 illustrates the pathway of sound in the human hearing mechanism.

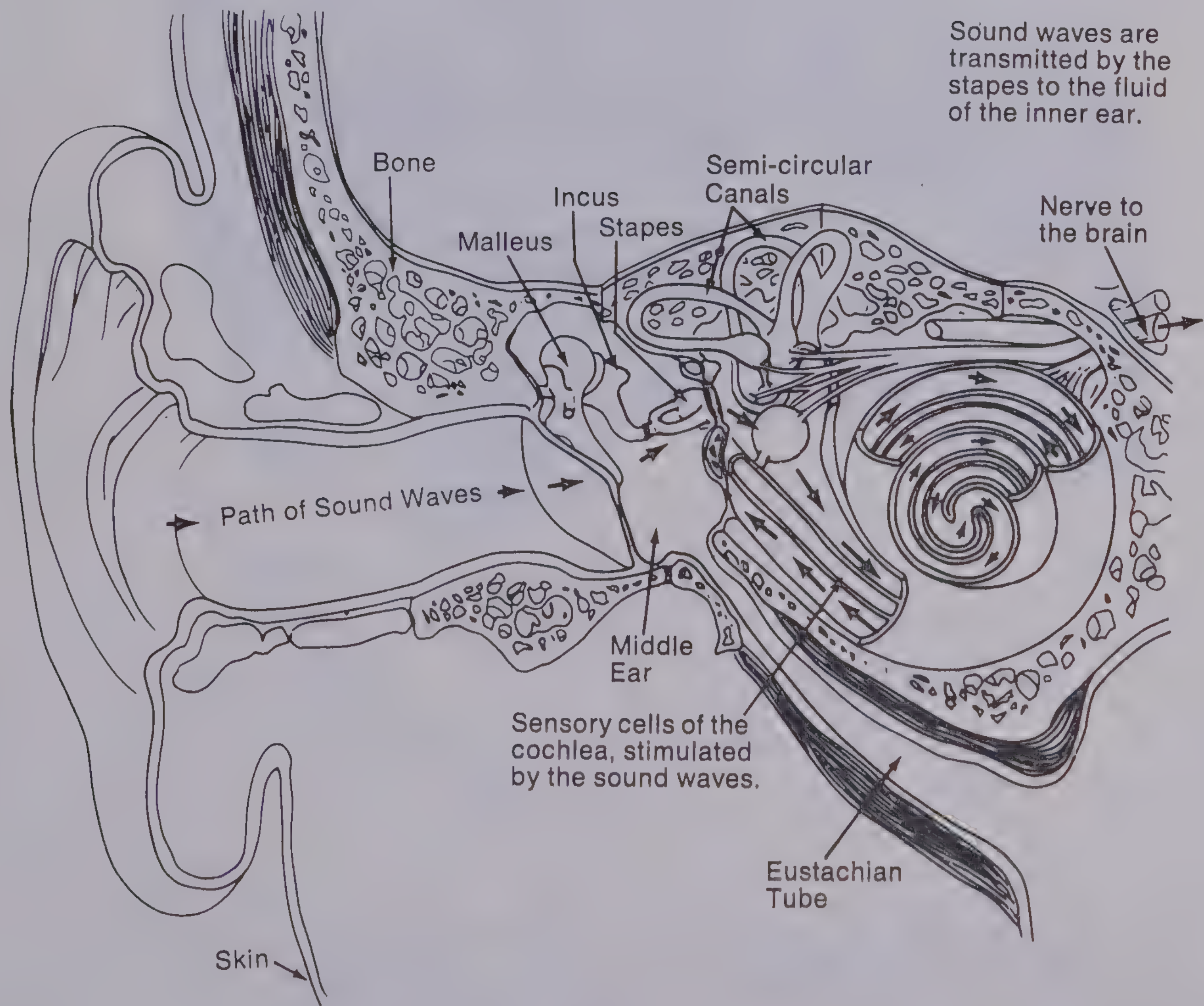


Figure 7. The pathway of sound in the human ear. (Taken from Industrial Noise and Hearing Conservation, p. 225).

A cross-section of the auditory mechanism, illustrating the outer, the inner and the middle ear, and the specific names of the various parts, is illustrated in Figure 8.

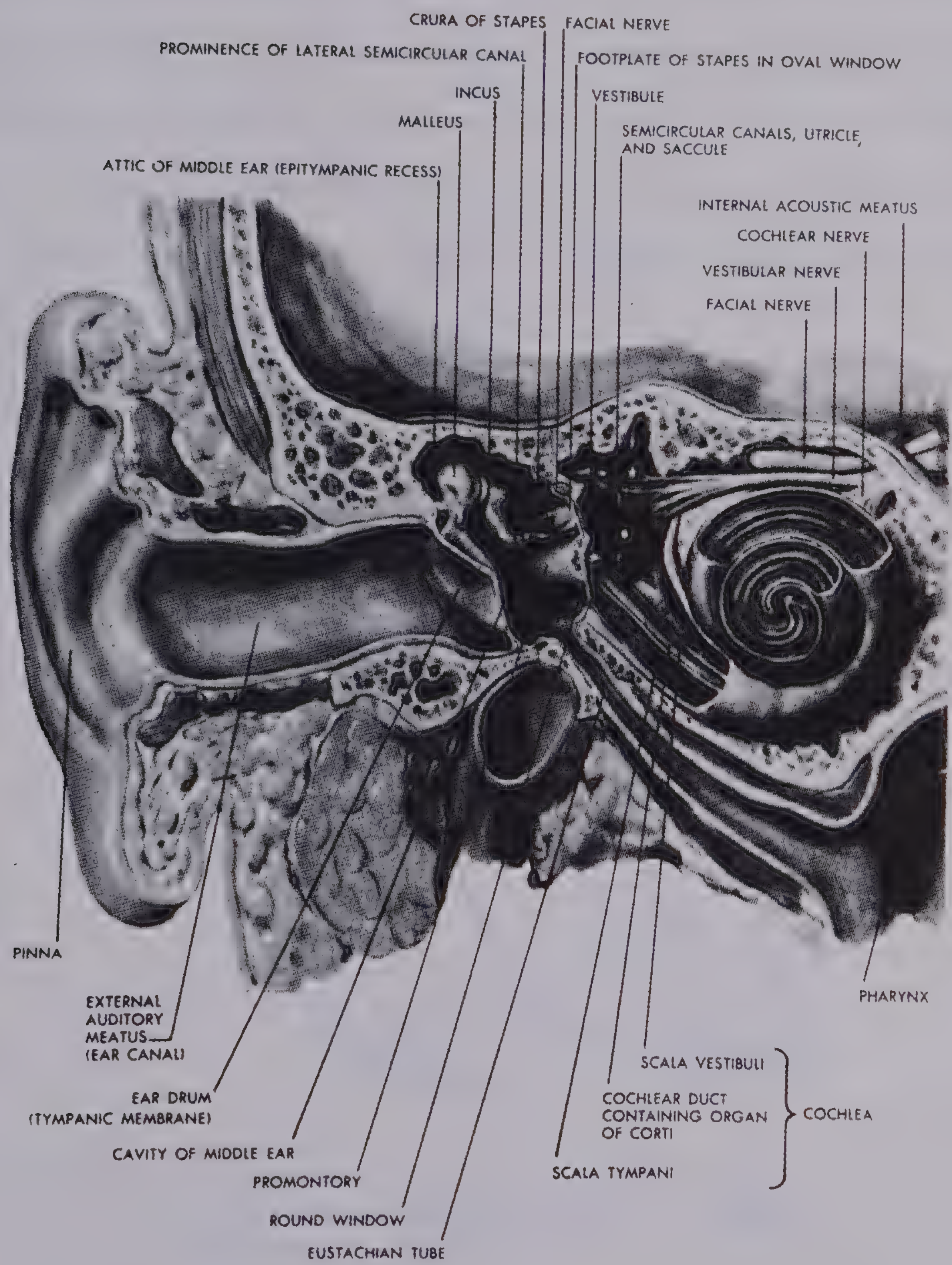


Figure 8. An illustration of the outer, middle, and the inner ear. (Taken from Industrial Noise and Hearing Conservation, p. 204).

Acoustical energy in the form of sound waves impinging upon the pinna, are funneled into the external auditory meatus or ear canal (DeWeese, 1977, p. 263). When this acoustical energy strikes the tympanic membrane or eardrum, it causes that body to vibrate, thus the conversion of acoustical energy to mechanical energy, is accomplished.

The tympanic membrane, as shown in Figure 9, is attached to a linkage consisting of three very tiny, but extremely important ossicles, or bones, known as the malleus (hammer), the incus (anvil) and the stapes (stirrup) (DeWeese, 1977, p. 265).

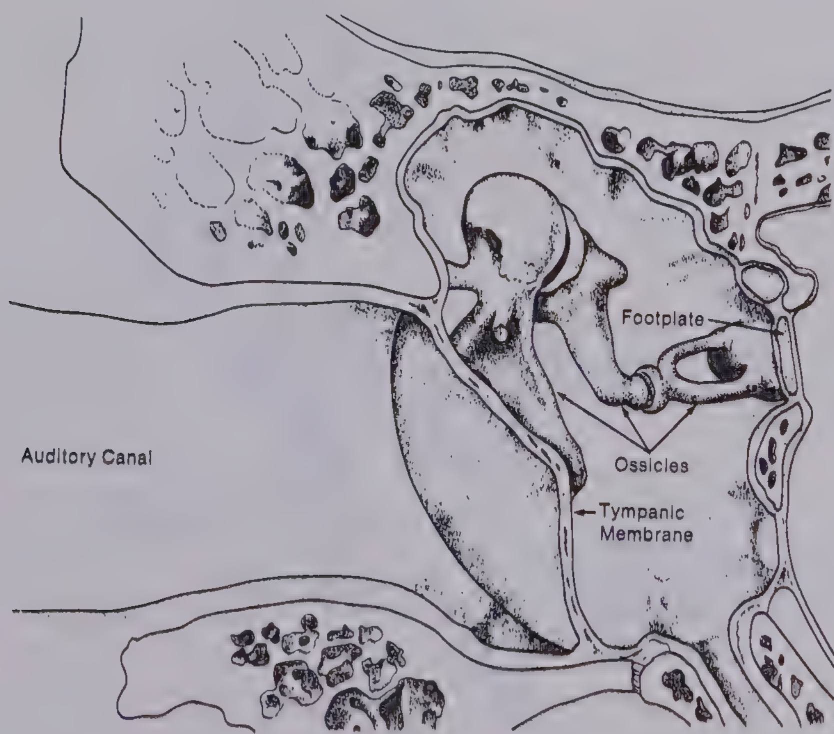


Figure 9. Detailed structure of the middle ear. (Taken from Industrial Noise and Hearing Conservation, p. 210).

It should be noted that the pressure within the middle ear is equalized with that of the outer ear by way of the Eustachian Tube which vents the middle ear cavity, as shown in Figure 8. Equalized pressure on both sides of the eardrum is extremely important, if the eardrum is

to function properly (DeWeese, 1977, p. 268).

The middle ear passes on mechanical energy in direct proportion to the original sound pressure level of the acoustical stimulus but with a 21 to 1 amplification factor (due to the relatively large size of the tympanic membrane when compared to the much smaller oval window) and ultimately, to the stapes footplate (DeWeese, 1977, p. 285). The stapes footplate is attached via the oval window to the vestbular system (site organ for the sense of balance) and the fluid-filled cochlea (i.e. the inner ear) (DeWeese, 1977, p. 268). This operation is detailed in Figure 10.

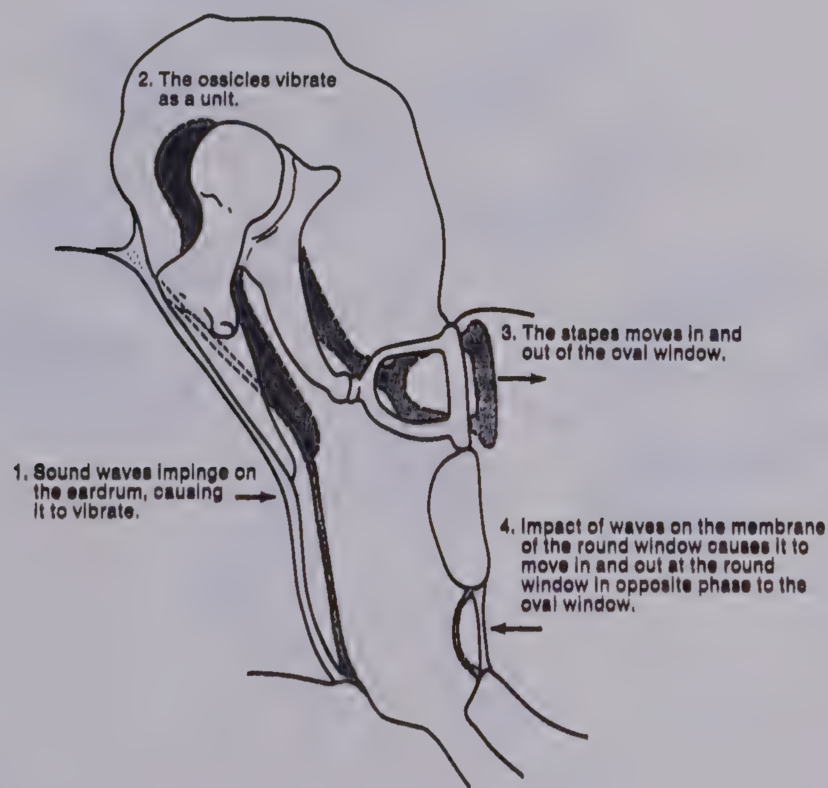


Figure 10. The mechanical operation of the middle ear. (Taken from Industrial Noise and Hearing Conservation, p. 212).

Since the effects of noise are generally the most degrading and harmful to the organ of Corti, contained within the cochlea, a closer look at that organ is desirable.

The illustration of the hearing mechanism in Figure 8 shows that the entire hearing system is encased within one of the thickest and strongest bones of the entire human body, the temporal bone, which protects, as much as possible, that extremely fine and sensitive system.

Figure 11 illustrates the interior of the cochlea which is made up of the canals, wound two and one-half times around itself (Sataloff,

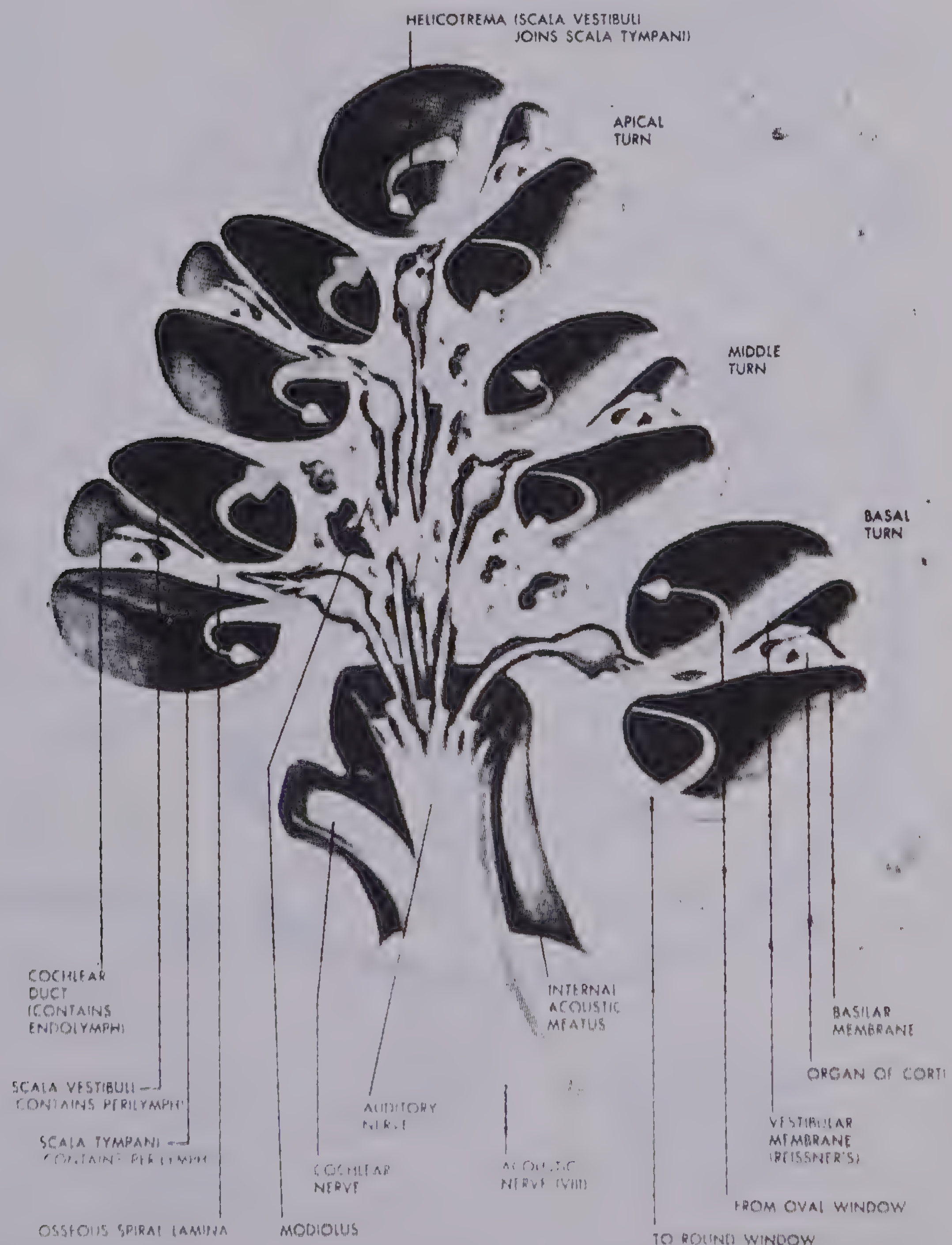


Figure 11. Cross-sectional view of the cochlea. (Taken from Industrial Noise and Hearing Conservation, p. 216).

1957, p. 24). The cochlea thus fits neatly into a very limited space.

The snail-shaped cochlea is filled with a fluid known as peri-lymph (DeWeese, 1977, p. 271). The function of the perilymph is to act as a hydraulic fluid. When this fluid is displaced by the action of the stapes footplate against the oval window, as shown in Figure 12, that

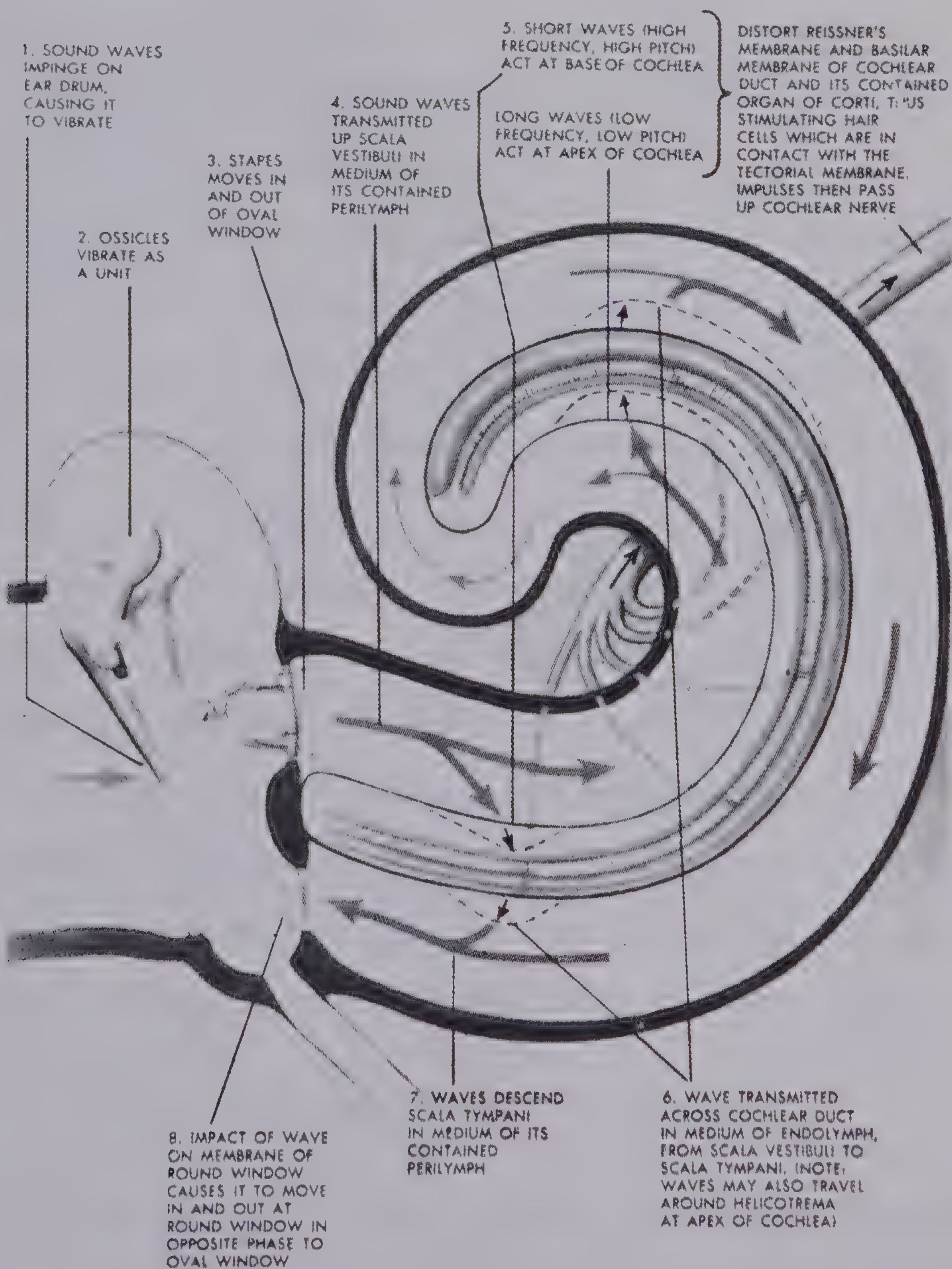


Figure 12. Sound transmission through the middle and inner ear. (Taken from Industrial Noise and Hearing Conservation, p. 219).

action causes a shearing movement which results in the fluid being displaced across the hair cells of the organ of Corti (DeWeese, 1977, p. 271). Each of these hair cells is attached to a nerve ending that causes electrical impulses to be set up. These impulses are then transmitted to the brain by way of the auditory nerve (see Figure 7) (DeWeese, 1977, p. 277).

The Organ of Corti

Figure 11 shows a cross-section of the cochlea, with the cochlear ducts magnified in Figures 13, 14 and 15.

The organ of Corti is situated on the basilar membrane and represents the end organ of hearing. There exists in four rows, 20 000 to 30 000 minute hair cells (Sataloff, 1957, p. 25). Each of these hair cells has a sensory nerve cell beneath it which must by physically stimulated by the displacement of the perilymph in order for the underlying nerve cell to be activated. These hair cells respond selectively to the different frequencies that the ear has received (Sataloff, 1975, p. 25). After the hair cell is stimulated, each nerve cell emits an electrical impulse, and impulses from tiny nerves branching into larger nerves, ultimately connect to the auditory nerve, and finally, to the temporal cortex region of the brain, where specific sound is sensed. In this manner, hearing is accomplished (Sataloff, 1957, p. 25).

GENERAL EFFECT OF NOISE ON HEARING

The general effect of very intense noise, or of prolonged exposure to noise, is that of causing irreparable damage to the sensory receptors of the inner ear, namely to the hair cells of the organ of

Corti.

According to the World Health Organization (1977), noise affects not only the physiology of the hearing mechanism, but produces deleterious side effects as well, such as interference with communication, the disturbance of sleep, the elicitation of stress and annoyance syndromes,

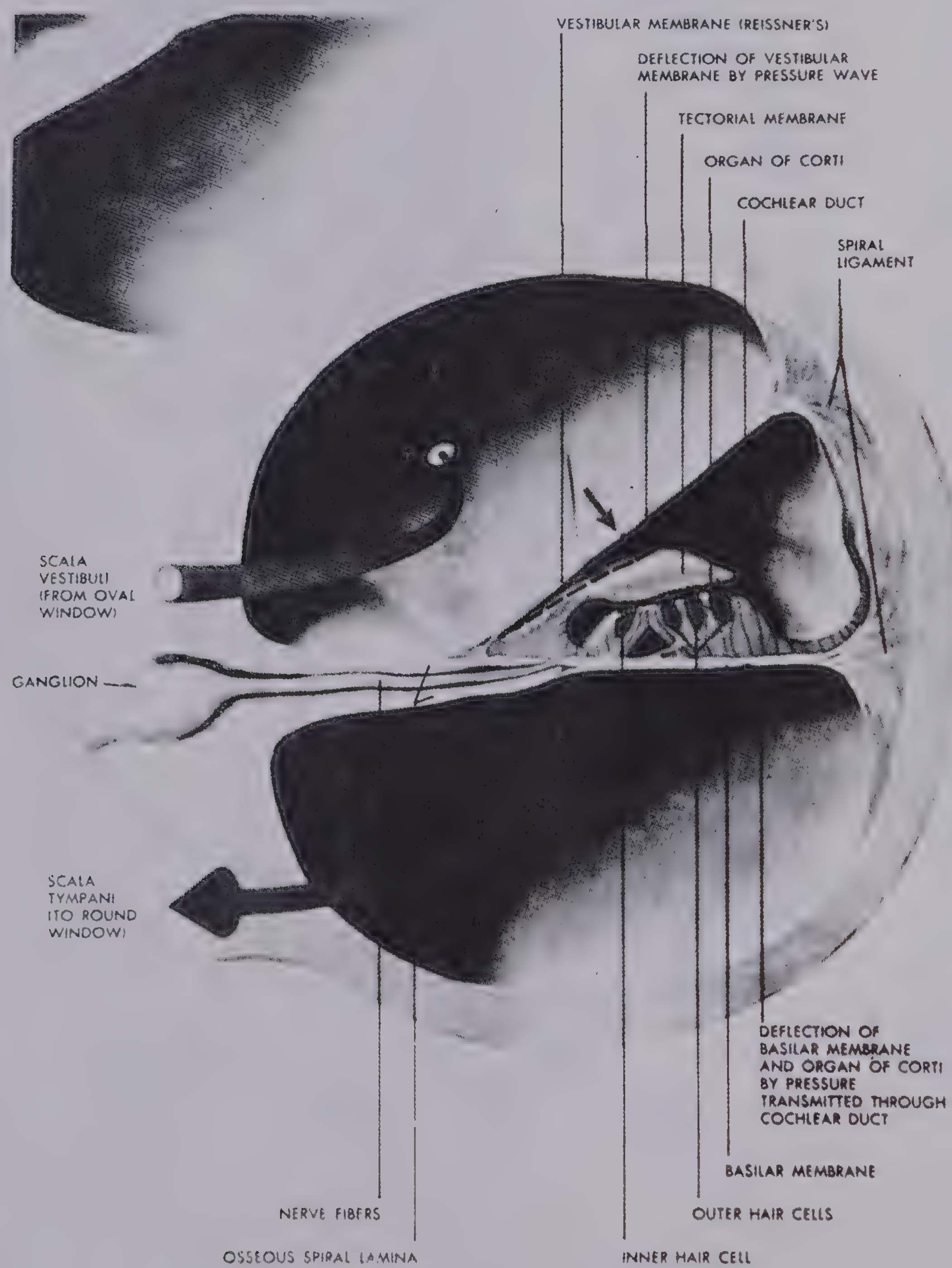


Figure 13. The transmission of sound across the cochlear duct, stimulating the hair cells. (Taken from Industrial Noise and Hearing Conservation, p. 217).

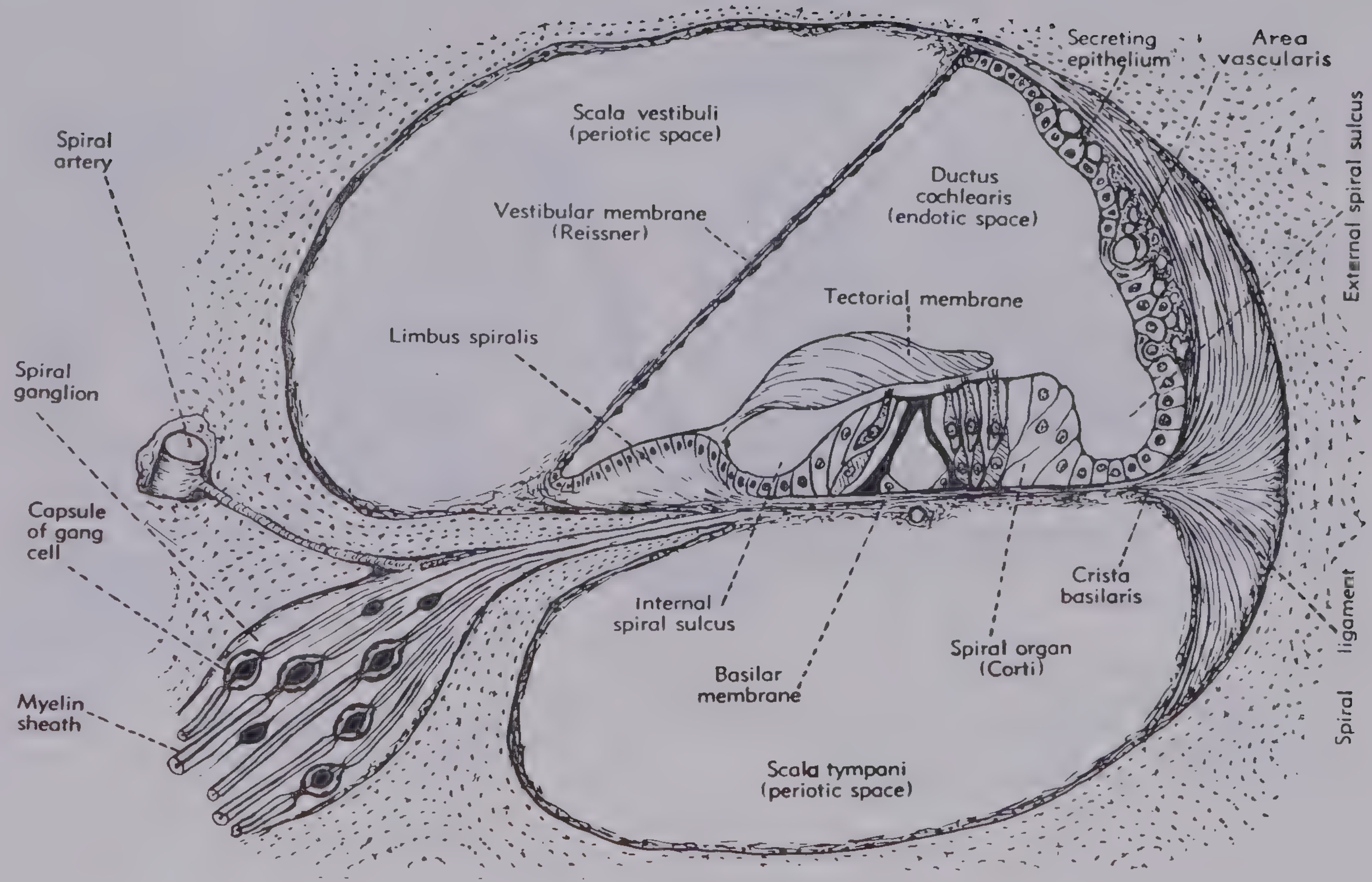


Figure 14. Cross-section of the organ of Corti. (Used with permission. Copyright 1966 by J. B. Lippincott Co. Taken from Hearing Loss by J. Sataloff, p. 108).

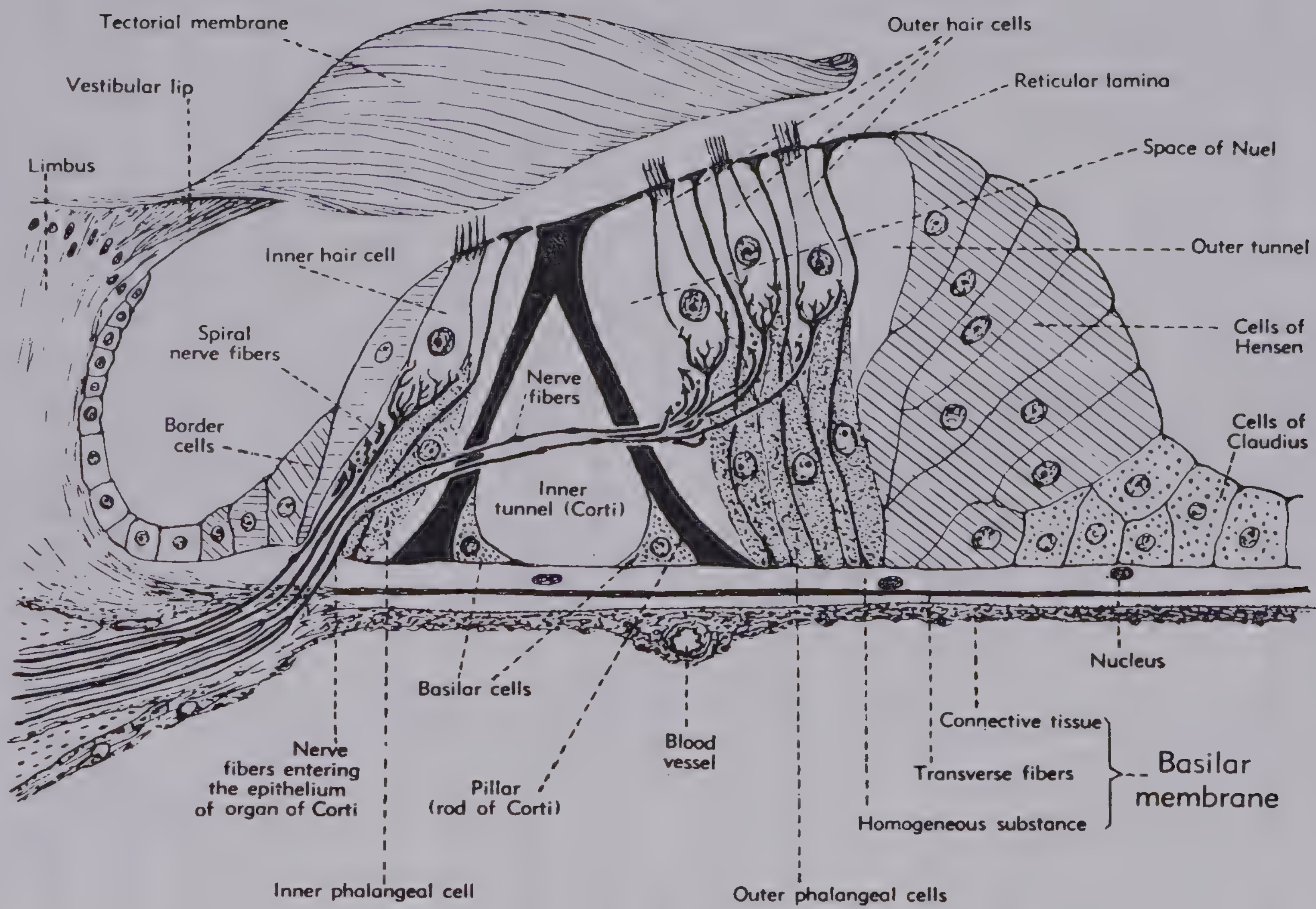


Figure 15. Cross-section of the organ of Corti (higher magnification of Figure 14). (Copyright 1966 by J. B. Lippincott Co. Taken from Hearing Loss by J. Sataloff, p. 109).

and a generally decreased performance on task-oriented activities (pp. 2-7).

A normal, young ear has an approximate hearing range of 20 to 20 000 Hz, which represents the maximum hearing range. As people grow older and approach middle age, an increasing sensory hearing loss or threshold shift, occurs. The higher frequencies are the most affected. This effect is known as presbycusis and is a natural part of the aging process and varies, to some extent, according to individual differences (Sataloff, 1957, p. 35). Some people, for unknown reasons, appear to be more susceptible to this loss than others. While young children can hear up to 20 000 Hz, many adults can only hear up to 14 000, 12 000 or 10 000 Hz. By the age of 70 years, most people cannot hear frequencies above 6 000 Hz (Sataloff, 1966, p. 124). Since the important speech range exists between 250 and 4 000 Hz, the ability to hear and comprehend speech accurately, is not really hampered in the aged. The most sensitive range, physiologically speaking, is that between 1 000 and 4 000 Hz, which encompasses the speech range and thereby is a prime target for noise-induced, sensory hearing loss (refer to Figure 6, p. 32). Exposing the ear to intense noise can lead to either a temporary or a permanent threshold shift, in an individual's ability to hear sound. However, such factors as overall sound pressure levels, the frequency of the noise, the duration and the individual's susceptibility to noise-induced hearing loss, are factors which must be considered.

Temporary Threshold Shift (TTS)

A temporary threshold shift (TTS) or auditory fatigue may be defined as "the temporary hearing loss suffered as the result of noise

exposure, if all or part of the loss is recovered during an arbitrary period of time when one is no longer subjected to the noise" (Olishifski, 1975, p. 1058). TTS is believed to be the result of an excessive stimulation of the hair cells of the organ of Corti and thus, after a period of rest (during which time the noise is no longer present) returns to normal (see Figure 16).

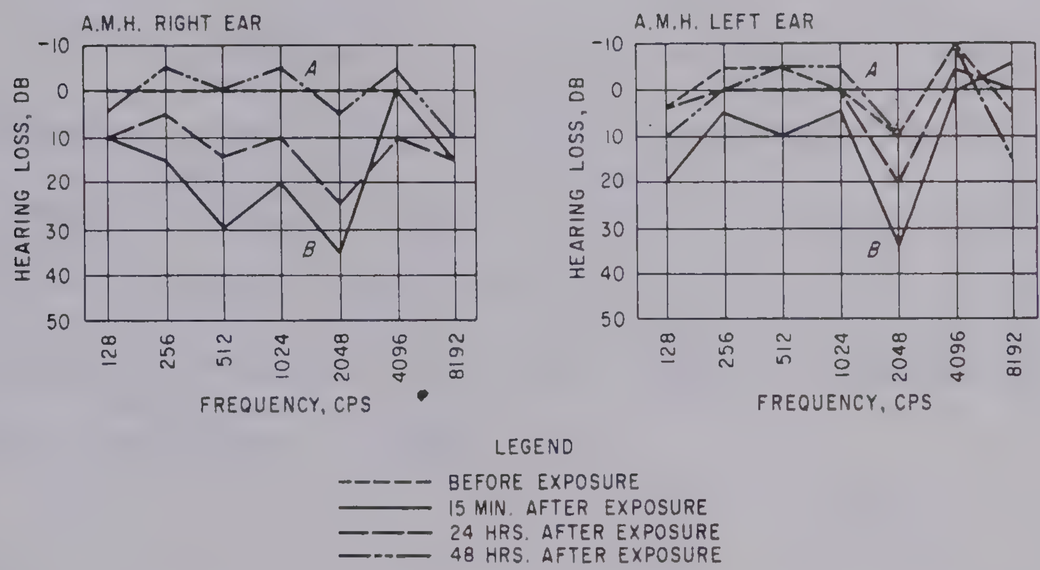


Figure 16. Subject was exposed to intense noise of a certain type of jet engine for a long period. The hearing loss (B) returned to its original level (A) after two days of rest. (Copyright 1966 by J. B. Lippincott Co. Taken from Hearing Loss by J. Sataloff, p. 179).

W. Dixon Ward (1969) in Noise As A Public Health Hazard found:

1. that TTS recovered usually within sixteen hours and when TTS had reached 40 dB or more, took days or even weeks to recover;
2. that low noises were less dangerous than high pitched noises, in producing TTS;
3. that TTS increases linearly with the average noise level at about 80 dB sound pressure level, at least up to 130 dB or so;
4. that an intermittent noise is much less able to produce TTS than a steady state one;
5. that neither growth nor recovery of TTS is influenced by drugs, medications, time of day, hypnosis, good thoughts or extra-sensory perception. The locus with the physiological deficit associated with TTS thus seems to be extremely peripheral - at the hair cells of the cochlea, to be specific; and

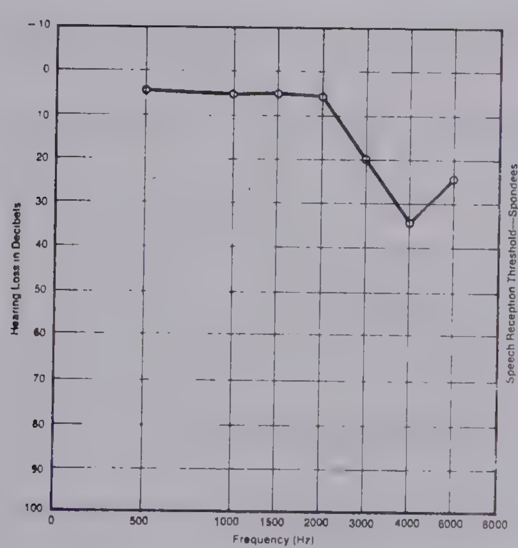
6. that steady noises above 80 dBA are incapable of producing TTS (pp. 41-46).

Noise-Induced Permanent Threshold Shift (NIPTS)

A noise-induced permanent threshold shift (NIPTS) can be defined as "the component of threshold shift which shows no progressive reduction with a passage of time when the apparent cause has been removed" (Olishifski, 1975, p. 1047).

The speech frequencies are generally the first to be affected with a characteristic dip in the 3 000 to 6 000 Hz range; usually appearing greatest at the 4 000 Hz level. This is shown in Figure 17. Often, this type of hearing loss continues unnoticed until it reaches the speech frequency range and the subject begins to experience difficulty in understanding normal speech.

A



B

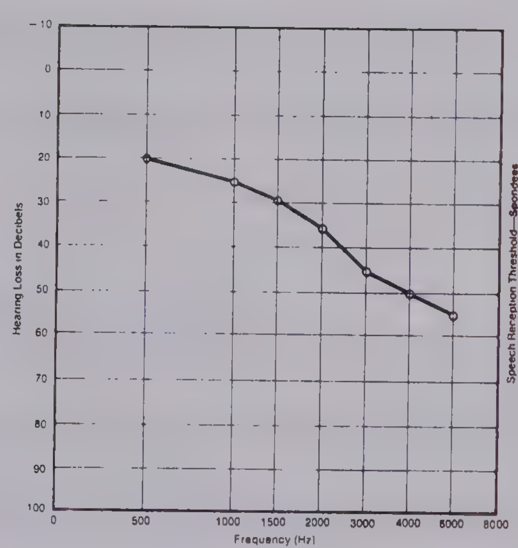


Figure 17. (A) The early stages of noise induced hearing loss is characterized by a sharp dip in the hearing threshold curve at the frequencies between 3 000 and 6 000 Hz, usually appearing at 4 000 Hz. (B) Impairment of hearing is not usually noticed by the individual until the important speech frequencies are affected. (Taken from Industrial Noise and Hearing Conservation, p. 236).

W. Dixon Ward (1969) in Noise As A Public Health Hazard, wrote the following information on NIPTS:

1. that the 4 000 Hz frequency range appears to be the area most sensitive to damage, the higher frequencies next;
2. that there is no proof that once NIPTS sets in, that it becomes progressive, assuming that the source of the noise has been removed;
3. that at present there is no cure for NIPTS;
4. that individual susceptibility to NIPTS is variable and that this susceptibility cannot be identified in advance; and
5. that steady noises above 105 dBA are sure to produce NIPTS in the normal unprotected ear if exposures persist eight hours a day for several years (pp. 44-46).

C. May, Director of the Division of Industrial Health for the Alberta Department of Health, presented a paper at a convention of the Canadian Speech and Hearing Association in 1970, entitled, "Hearing Loss Associated with Occupational Exposure to Noise". In that paper, May pointed out that out of Alberta's labour force of 600 000, a conservative estimate that 10 percent, by the end of their working life, would experience a hearing loss that would be "directly and undeniably attributable to noise arising out of their former occupational environment" (p. 2).

CURRENT HEALTH AND SAFETY STANDARDS

The current health and safety standards for noise in industry are set by legislation in both Canada and the United States. These standards are based upon research data with regard to level, frequency and time characteristics that seem most likely to avoid hearing impairment and threshold shift. Such characteristics as level, frequency and time, are founded in research statistics and are known as damage-risk criteria. According to von Gierke and Johnson (Henderson, 1976),

damage-risk criteria "describe the relationship between the probability of incurring noise-induced hearing impairment and the exposure environment" (p. 547).

Damage-Risk Criteria

According to Eldridge (in Fricke and Ward, 1969), damage is very difficult to define inasmuch as a direct examination of the cells and tissues of the inner ear is not usually possible until after death (p. 10). Further, no medico-legal precedent exists for either measuring or evaluating damage in terms of impairment of hearing. Since the most important function of the ear is to hear everyday speech, a definition of damage should logically reflect on the ability to hear and interpret everyday speech. One must consider not only intensity level, but duration and frequency of the noise or sound, as well. Accordingly, in the *Industrial Noise Manual*, damage is defined as "any permanent increase in auditory threshold" (p. 36). In addition, the National Institute of Occupational Safety and Health (NIOSH) defines hearing impairment as considered to have occurred "when the average of the hearing threshold levels at the audiometric frequencies of 500, 1 000 and 2 000 Hz, for both ears, exceeds 25 dB" (Olishifski, 1975, p. 918). A standardized concept for damage and impairment can be found in those terms.

On Seeking Good Damage-Risk Criteria

Acceptable damage-risk criteria that appears in the legislation in Canada and the United States falls into the 85 to 90 dBA range, for an eight hour period. Although this criterion has been written into the legislation, among authorities there remains much conjecture as to what is a safe level of noise exposure.

Ward and Eldridge (1969), strongly suggest that noise environments below 80 dBA are certainly safe (Noise As A Public Health Hazard, p. 120). On the other hand, von Gierke and Johnson (in Dosanjh, 1976) state that "it is clear that neither 85 nor 90 dBA is a truly safe level. They might be practical levels we must settle on, based on feasability determined at this instant in time" (p. 547). These authorities add:

> for noise exposure levels to have no effect on a population's hearing after 50 years of daily exposure, a 'safe' level of approximately 75 dBA is derived following the arguments advanced in the Environmental Protection Agency (EPA) 'Levels Document' (p. 547).

Von Gierke and Johnson (1976), point out that the 85 dBA level would still allow for a damage factor of 12.8 percent of the population, while that of 90 dBA would be damaging to 16.6 percent (in Donsanjh, 1976, p. 559). Ultimately, a standard that is both reasonable and humane must be decided upon. Figure 18 shows an 85 dBA damage-risk criterion curve for an eight hour day.

Legislation in North America

In the United States, the Occupational Safety and Health Act of 1970 (OSHA) established the 90 dBA limitation for an exposure period of eight hours (Olishifski, 1975, p. 861). In 1972, the National Institute for Occupational Safety and Health (NIOSH) published criteria that established a new standard of 85 dBA for an eight hour exposure period, for "all newly designed installations six months after the effective date of the standard" (Olishifski, 1975, p. 925).

In Canada, and with particular reference to Alberta, the adopted standard for noise exposure level is that of the 85 dBA level for an equal or equivalent exposure period of eight hours. That legislation

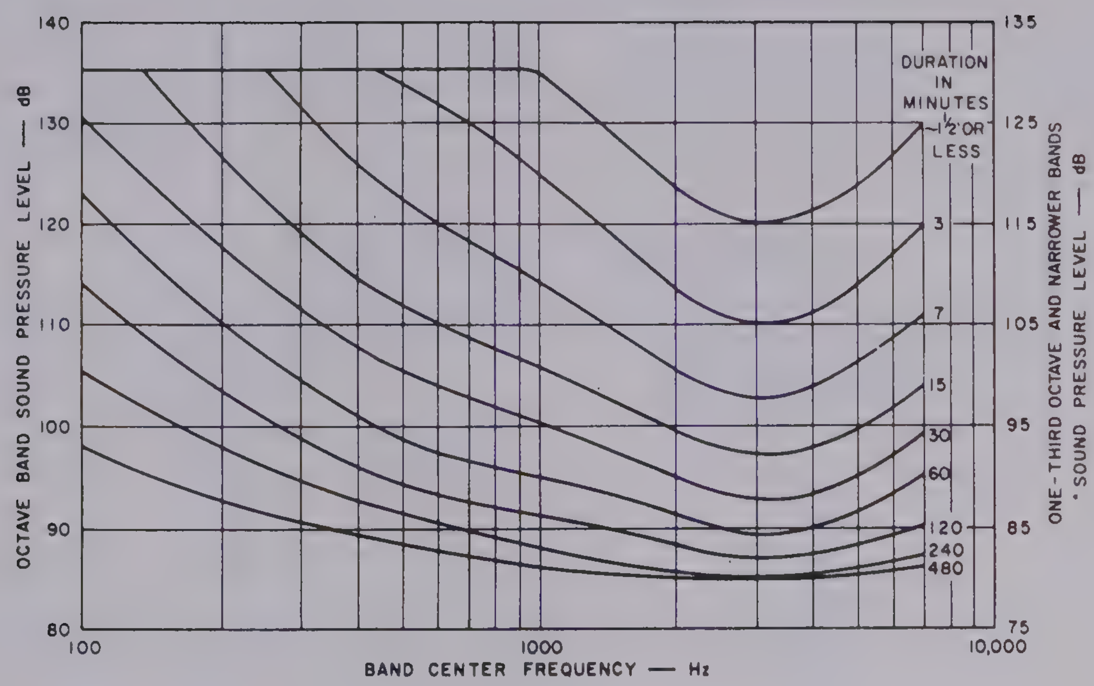


Figure 18. Damage-risk contours for an eight hour day. (Taken from Industrial Noise and Hearing Conservation, p. 304).

appears as follows:

DIVISION 29 ALBERTA PROVINCIAL BOARD OF HEALTH

"Regulations Respecting the Protection of Workers

From the Effects of Noise (1973)"

Relevant Sections

Noise Measurement

29-1-1 Noise measurement shall be expressed as the sound level in decibels when measured on the "A" scale of a standard sound level meter at slow response.

Exposure to High Noise Levels

29-2-1 In areas where high noise levels exist, the daily exposure for any person without ear protection shall not exceed the periods set out in Table 1 . . .

29-2-3 Where any person is required to work in noisy areas where the sound levels exceed the criteria set out in Table 1, the employer shall take appropriate measures to suppress such noise to the specified levels and, if it is not reasonably practicable

to decrease the noise or isolate the worker from the noise, the worker shall be supplied with and shall wear personal protection equipment which will effectively attenuate the noise to acceptable levels. (2) Personal protective equipment required by subsection (1) shall be supplied at the employer's expense.

Permissible Noise Exposures

Duration Per Day, Hours	Sound Level dBA Slow Response
16	80
8	85
4	90
2	95
1	100
½	105
¼	110
1/8 or less	115

Alberta Provincial Board of Health Publication, 1973.

THE ALBERTA INDUSTRIAL ARTS MULTIPLE ACTIVITY LABORATORY

In a study involving noise exposure in senior high industrial arts laboratories, the physical layout of the laboratory and the equipment housed in the laboratory assume a major role in either creating or suppressing a noisy environment. The layout of the industrial arts laboratories in the schools of Alberta is closely related to the changing and evolving concept of industrial arts in the province since the time that manual training was first brought into the schools of the province.

From Manual Training to the Alberta Plan

Manual training which was the forerunner of industrial arts, began in Alberta near the turn of the century and focussed primarily on specific exercises in woodworking, mechanical drawing, and metalworking

(Smith, 1973, p. 25). The purpose of manual training according to Gallagher (1963), lay in the fact that it was considered part of one's general education and that emphasis was placed upon technical skills for mental rather than for specific trade competencies (p. 33).

During the mid-1920's, the concept of manual training evolved into that of the manual arts, which tended toward greater freedom, less formality, and greater emphasis on aesthetic design, than had previously been the case with manual training (Barlow, 1967, p. 249). The manual arts approach employed hand processes and materials in a craft relationship rather than drawing on industry for its tool processes, and was taught in a unit shop (Gallagher, 1963, p. 34).

The "general shop" was introduced into Alberta in 1938 as the organizational pattern for teaching the content of industrial arts (Smith, 1973, p. iv). The majority of the shops in the province where industrial arts was taught, were organized as unit shops where either woodworking, metalworking or drafting was taught.

Silvius and Curry (1956) give the following definition for the term "general shop":

> a shop in which two or more activities, such as woodworking and metalworking are organized and carried on concurrently under the direction of one teacher (p. 460).

The program of studies in Alberta that was offered in a general shop was confined to that of either woodworking, metalworking or drafting. This program came to be known as "the traditional program".

More recently, between 1962 and 1972, a changeover from "the traditional program" which had been organized on a unit shop basis to that of the "Alberta Plan" was undertaken. This change required that the learning environment, for teaching industrial arts, be restructured

from a unit shop to a multiple activity laboratory where three or more activities are in progress at the same time (Cochran, 1970, p. 74).

The learning activities taught in a multiple activity laboratory might include any of the following fields of study: Electronics Technology (i.e., electricity, electronics, power supplies, amplifiers, radio, television, logic circuits, computer, electric wiring, design and construction, audio and servicing); Materials Technology (i.e., general woods, building construction, cabinet making, general metals, sheet metal, machine shop, welding (gas and arc), foundry, plastics, ceramics, textiles, foods); Power Technology (i.e., conventional heat engines, small engine tune-up and overhaul, automobile care and tune-up, mechanical systems, electrical systems, electro-mechanical controls, nonconventional power systems, appliance repairs, hydraulics and fluidics, pneumatics and fluidics); Visual Communications Technology (i.e., offset lithography, line photography, black and white, and colour photography, screened photography, layout and design, offset printing and production, mechanical drafting, topographical drafting, architectural drafting, relief printing, print-machine techniques); and General Modules (i.e., developmental, research, production science)(<u>Handbook in Industrial Education</u>, 1976, p. 8).

<u>Multiple Activity Rationale</u>

The Department of Education, in its publication, <u>Industrial Arts Laboratory Planning</u> (1968), gives the following rationale for organizing the learning environment for industrial arts, as multiple activity laboratories:

1. The inter-relationships of the technologies can be better

illustrated.

2. Provision can be made for many different areas of activity which would otherwise not be economically possible.

3. It is possible to better meet the needs and interests of a heterogeneous student group, through an environment that resembles in part at least, the diversity of activity found in the world of work.

4. While students carry out the major portion of their activities in the area or bay designated for it, they, nevertheless, get some familiarity with the various other activities that are going on around them (pp. 5-6).

In addition, that source points out the necessity of the program being both highly-structured and well-organized for its successful operation to be realized.

The Multiple Activity Approach Defined

The Junior High Industrial Education Guide (1976), an official publication of Alberta Education, defines the multiple activity program and approach in this way:

> The multiple activity program is an organizational device by means of which a variety of exploratory experiences can be presented with a minimum of room and equipment. The laboratory is organized into a number of different sections representing the fields of study (i.e., Electronics Technology, Materials Technology, Visual Communications Technology and Synthesizing - mine). Each section or bay is large enough to accommodate 4 to 6 students (p. 4).

Each of those areas mentioned has a complete compliment of the necessary hand tools, special purpose machine tools, and expandable supplies needed by the student to complete successfully, a learning activity with a material or a technology (Preitz, 1973, p. 90).

In further describing the area organization of a multiple activity laboratory, Preitz (1973) wrote:

> these areas are organized to make them as autonomous as possible, to minimize the amount of inter-area traffic, and to maximize the learner's time while he is in the laboratory by having everything available to him to use (p. 90).

Included in each area of the industrial arts laboratory is an area library which might contain an extensive collection of special and advanced reference books, and other forms of printed materials such as Pictorial Programmed Instruction (P.P.I.) texts or Articulated Instructional Development (A.I.D.) texts for the student to use as he studies a manufacturing process or a technology (Preitz, 1973, p. 90).

An integral part of the multiple activity laboratory learning environment is the Instructional Materials Centre (I.M.C.) which is a small room that serves as:

> the core repository for the housing and distributing of the major items of software and hardware used for learning. The I.M.C. contains books, transparencies, filmstrips, slide-tape presentations, videotapes, and models, as well as the apparatus either to project or record these visual materials (Preitz, 1973, p. 90).

In the industrial arts laboratory of the 1970's, every effort is made to individualize instruction so that the responsibility for learning is placed on the learner. The role of the teacher changes drastically "to that of a resource person, instructional materials designer, manager of the learning environment, and a motivator of the learner" (Preitz and Andrus, 1979, p. 4).

The configuration that a multiple activity laboratory can have is rectangular, square, round, hexagonal and octagonal (Industrial Arts Laboratory Planning, 1968, pp. 9-11). The majority of the laboratories in the province are of the rectangular design and contain at least 3600 sq. ft. of floor space for a single teacher laboratory, which is normally the case at the junior high level. The School Buildings Regulations (1977), an official publication of Alberta Education, lists the number of square feet (i.e., floor area) for the following multi-teacher

laboratories, which are normally found at the senior high school level. According to these Regulations (1977), the areas are as follows:

single teacher laboratory	3200 - 3600 sq. ft.
double teacher laboratory	4600 - 5600 sq. ft.
triple teacher laboratory	6600 - 7600 sq. ft.
quadruple teacher laboratory	8600 - 9600 sq. ft. (p. 15).

Figures 19, 20 and 21, illustrate some typical two, four and five teacher, multiple activity industrial arts laboratories that may be found in the province.

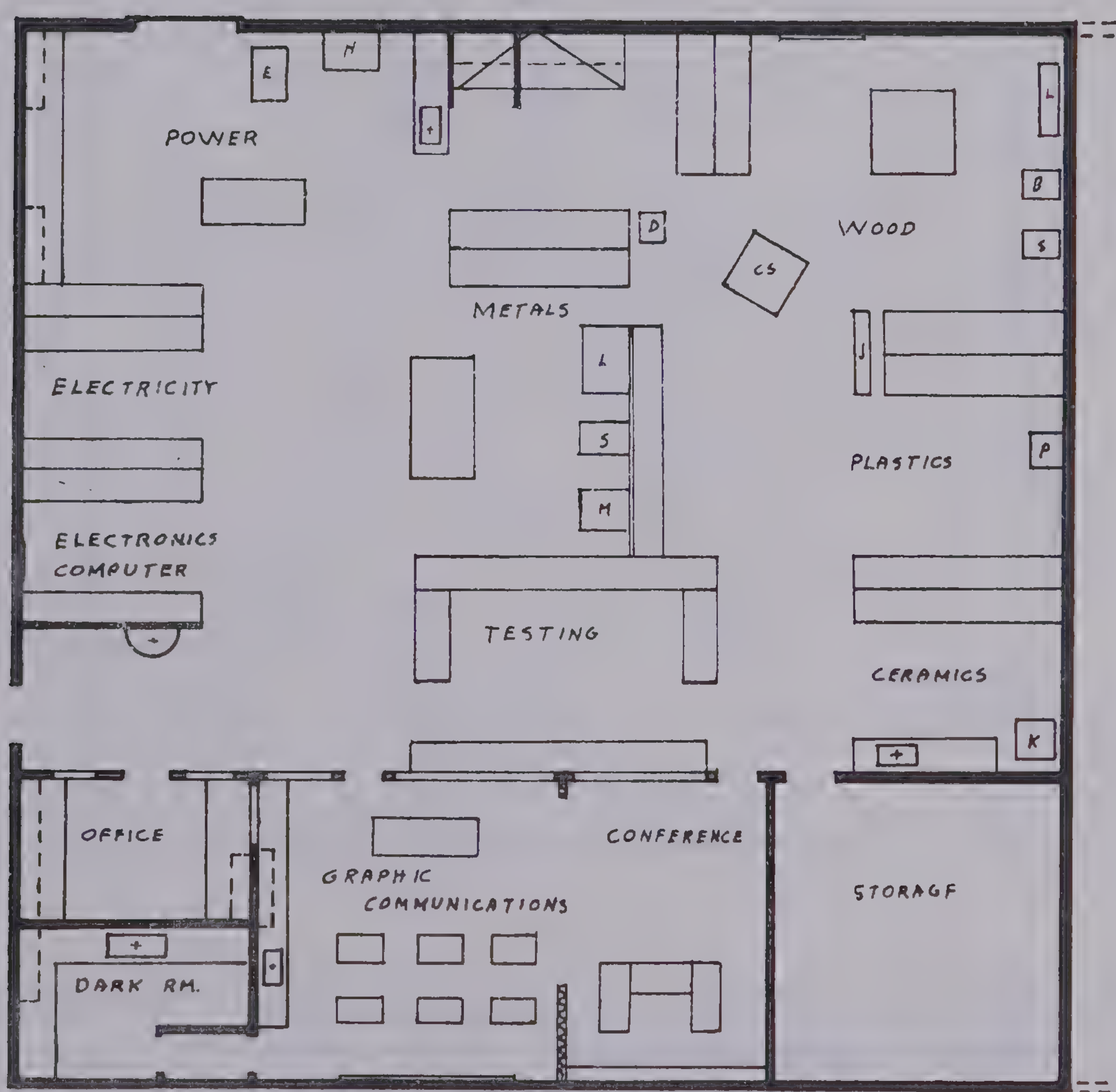


Figure 19. A typical two teacher industrial arts laboratory of 4,800 sq. ft. (Industrial Arts Laboratory Planning. Alberta Education, 1968, p. 35).

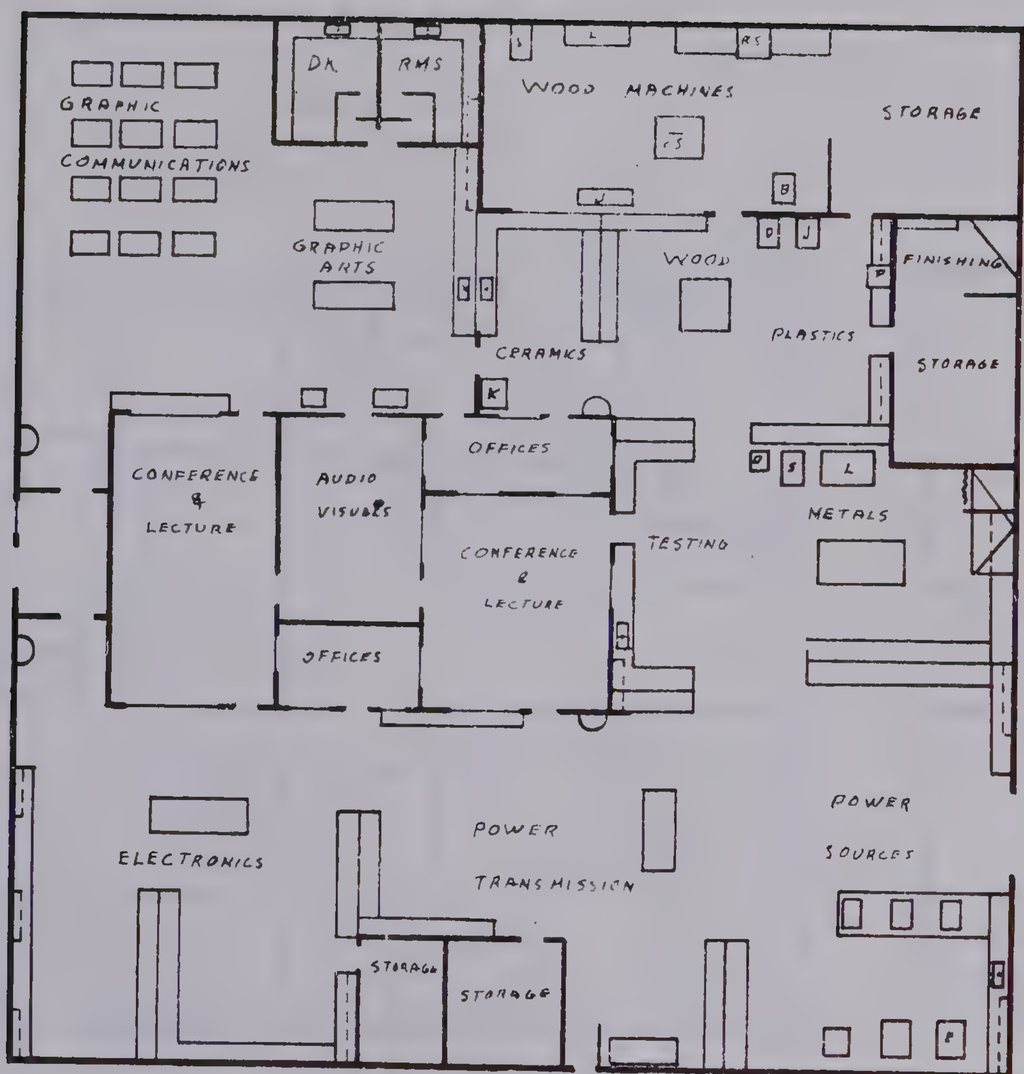


Figure 20. A typical four teacher industrial arts laboratory of 9,600 sq. ft. (Industrial Arts Laboratory Palnning. Alberta Education, 1968, p. 37).

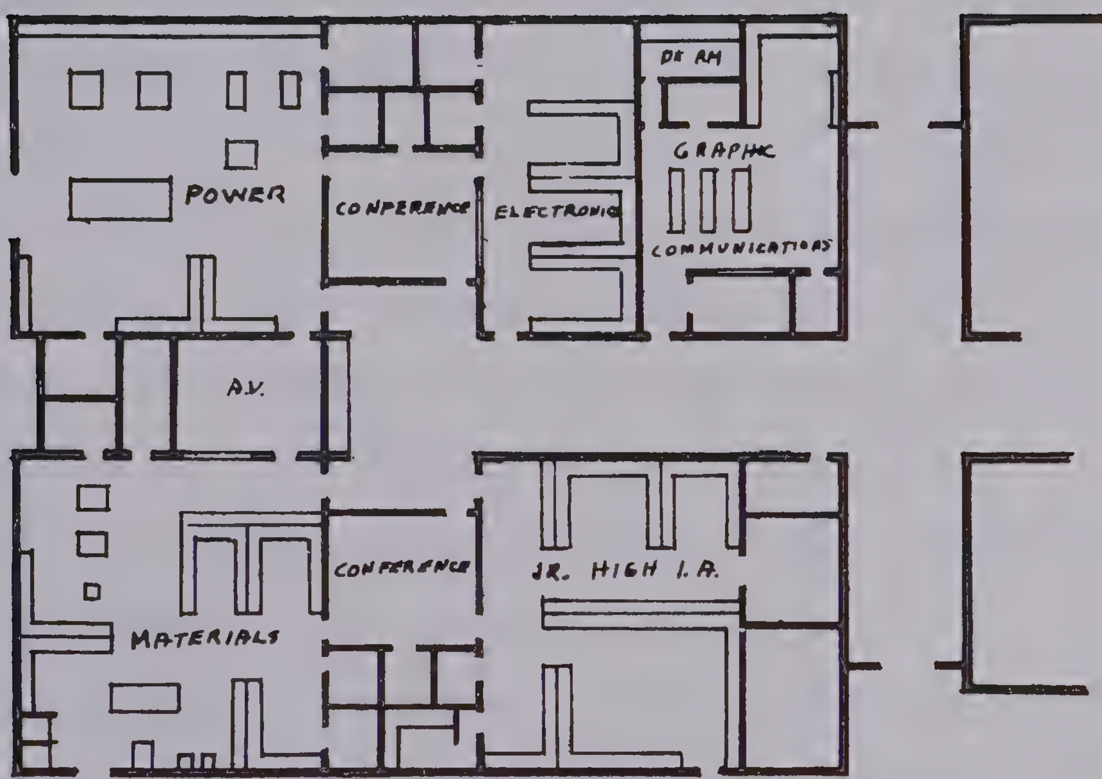


Figure 21. A typical five teacher industrial arts laboratory of 12,000 sq. ft. (Industrial Arts Laboratory Planning. Alberta Education, 1968, p. 38).

Possible Sources of Noise in a Multiple Activity Laboratory

Essentially, the greatest possible source of noise in a multiple activity laboratory is generated by the machines in each of the areas where machines are used to cut, to shape, or to form a material. Another possible source of noise in this learning environment is when the teacher and/or the learner become involved in some type of manufacturing process used to make a product.

Although all industrial arts laboratories are not identically equipped, Alberta Education, in 1973, released the Industrial Arts Equipment List. On this list are the machines and hand tools that the Department of Education recommends for each area, that are needed to maximize instruction for industrial arts students. That document lists the following machines for each of the materials or technologies areas:

Metals Area: bender, brake (box and pan), foundry kit (crucible furnace, anvil, equipment for green sand molding), grinder, power hacksaw, lathe, milling machine, shears, spot welder, electric arc welder, gas welder, drill, roller, combination rotary machine, seamer, shaper, stake.

Plastics Area: air compressor, buffing and polishing unit, injection press, vacuum and blow-forming kit, welding torch.

Woods Area: electric drill, drill press, dust collectors, grinder, wood lathe, band saw, circular saw, jointer, laminating press, lathe duplicator, portable electric router, portable electric sander, radial arm saw.

Graphics Area: offset duplicator, electrostatic copier and converter, table-top offset duplicator.

Power Area: internal combustion engines (single and multi-

cylinder), welding units (both gas and arc), grinders.

In addition to the above, there is a wide variety of portable hand tools, both manual and power, which could be noise-producing under standard conditions of operation.

Chapter 3

THE ANALYSIS OF DATA

The preceding chapter presented a review of the professional literature that was directly related to the topic of noise, noise exposure levels, and an overview of the environment where industrial arts is taught.

This chapter focuses on a physical description of each of the industrial arts laboratories that made up the population of the study, and the data that were collected in these laboratories during the research. These data are presented in tabular form and will be analyzed for the benefit of the reader.

In addition to the above, there is a section of this chapter that describes the amount of time that those industrial arts teachers, who participated in the study, spend in their laboratories teaching students.

Researcher's Note

It should be noted that all data contained in the tables of this chapter are based upon percents of the 8 hour/85 dBA time/level exposure limitation, as per regulations prescribed in The Alberta Occupational Health and Safety Act (1976). These were derived and converted to 8 hour equivalents by applying the following conversion formula to the data that were collected in each area of each of the laboratories:

$$\frac{8}{B} \times A = \text{8 hour equivalent percent}$$

where B represents the number of hours of exposure and A represents the percent readout given by the noise dosimeter unit. For example: any percent less than 100 would indicate a non-violation of the 8 hour/85 dBA time/level exposure and conversely, a percent greater than 100 would indicate a violation of the exposure regulation.

The Alberta Occupational Hygiene Branch suggests and advocates that percent noise exposures in excess of 50 are definite levels for concern, and therefore, merit further investigation and testing in terms of being hearing-safe.

A DESCRIPTION OF PARTICIPATING INDUSTRIAL ARTS LABORATORIES AND A COMPARISON OF NOISE LEVELS IN EACH AREA OF THESE LABORATORIES

McNally Composite High School

The industrial arts laboratory at McNally Composite High School was selected as the pilot school for this study. A pilot study was completed so that the researcher could become familiar with the operation and use of the noise dosimeter, and to pretest the research design. Because of the limited number of schools involved in this study, this school was also included as a school in the research population.

The laboratory at this school is a quadruple teacher laboratory and has the following physical characteristics:

Location: ground floor; separate wing from the main building.

Geometric Shape: a slightly elongated square with a conference room in the approximate centre of the laboratory.

Surface Area: 7200 square feet.

Ceiling: 10 feet high; ribbed concrete throughout, except for the conference room which has a drop acoustical tile ceiling.

Wall: exterior walls are of concrete blocks; interior walls are of drywall construction.

Floor: concrete throughout, except for linoleum tile in the

conference room.

Acoustical Treatment: very little, aside from the occasional bulletin board found on the walls of the laboratory and ancillary rooms, and the acoustical tile ceiling in the conference room.

Other: the laboratory contained a separate engine test room, darkroom, storage rooms, and the teachers' office, along one wall of the laboratory.

Learning Activities Taught: Electronics Technology, Materials Technology, Power Technology, and Visual Communications Technology.

The following pieces of capital equipment in this laboratory that may be noise-generating in each area where a learning activity was taught are:

Electronics Technology (includes Electricity, Electronics and Computers) - none reported; the teacher who taught this technology reported that the noise generated by capital equipment used to work a material in the other areas of the laboratory adversely affected the learning situation and general levels of concentration of students working in the Electronics Technology area.

Materials Technology (includes woods, cold metals, sheet metal, plastics and materials testing - Woodworking Equipment: drill press, buffer, grinder, wood lathes, band saw, circular saw, radial arm saw, scroll saw, shaper, combination belt/disc sander, surface planer; Metalworking Equipment: drill press, grinders, metal lathes, power hacksaw, milling machine, plus a variety of portable electric hand tools - routers, drills and sanders.

Power Technology (includes conventional heat engines, small engine tune-up and overhaul, and electrical systems) - a number of four cycle internal combustion engines that had either four or six cylinders, as well as a number of small two cycle internal combustion engines; these were operated in a separate, well-ventilated engine test room. Also included in the area where Power Technology was taught was a welding station that had equipment for electric and gas welding.

Visual Communications Technology (includes offset lithography, black and white photography and mechanical drafting) - one Addressograph-Multigraph Model 1250 offset duplicator.

Data in Table 1 show the percent noise exposures in each of the four technologies taught in the pilot school. These data also show whether or not the individuals working in any of the four technologies wore hearing protection.

Table 1

Percent of Noise Exposures of the 85 dBA/8 Hour Limit, Hearing Protection Worn in the Laboratory at McNally Composite High School

Technology Taught	Noise Exposure	Hearing Protection	
		Yes	No
Electronics	0		X
Materials	74.6		X
Power	10.6		X
Visual Communications	0		X

It is evident from the data in this table that the learning activities directed toward constructing projects in the Materials Technology had the highest percent noise exposure - 74.6. This percent is 24.6 above the 50 percent level for concern advocated by the regulatory branch of Alberta Labour.

The percent noise exposure recorded for the Power Technology area for the research period was 10.6 - a level well below 50 percent. This level must be considered non-problematic as far as possible ear or hearing damage, caused by noise exposures, is concerned.

Also evident from the data in this table is that the noise exposures in both the Electronics Technology and the Visual Communications Technology areas were recorded at a level of 0 percent: levels which are considered safe for individuals working in these two areas.

Hearing protection was not worn by either the industrial arts teachers or the students who were working in the four technologies of this school.

Queen Elizabeth Composite High School

The industrial arts laboratory at Queen Elizabeth Composite High School is located on the second floor of the school. This laboratory has the following physical characteristics:

Classification: five teacher laboratory.

Geometric Shape: basically that of a rounded "L"; the result of two different size rectangles meeting at right angles; each rectangle has an approximate proportion of 2 to 1, length to width.

Surface Area: 9700 square feet.

Ceiling: 10 feet high; drop acoustical tile.

Wall: exterior walls of concrete blocks; interior walls of dry-wall construction.

Floor: linoleum tile throughout.

Acoustical Treatment: very little, aside from the use of acoustical tiles on the ceiling and bulletin boards mounted on certain walls.

Other: this laboratory contained a separate and well-ventilated engine test room in the Power Technology area. Also, there were separate rooms for arc and gas welding, photographic darkrooms, storage, a conference room, and teachers' offices.

Learning Activities Taught: Electronics Technology, Materials Technology, Power Technology and Visual Communications Technology.

The major pieces of capital equipment that may be noise-generating in each of these areas is as follows:

Electronics Technology (includes Electricity and Electronics) - none reported.

Materials Technology (includes woods, cold metals, sheet metal, plastics and materials testing) - Woodworking Equipment: drill press, buffer, grinder, wood lathes, band saw, circular saw, radial arm saw, scroll saw, shaper, combination belt/disc sander, surface planer, Uni-plane; Metalworking Equipment: drill press, grinder, metal lathes, band saw, power hacksaw and milling machine, plus a number of portable electric hand tools - router, drills, sanders and high-speed disc sanders.

Power Technology (includes conventional heat engines, small engine tune-up and overhaul, pneumatic and fluidic systems, and automotive electrical systems) - a number of two and four cycle internal combustion engines, the latter were either V8 or 6 cylinder, and were housed in a separate, enclosed engine test room. Gas and arc welding were also taught in this area but in a separate room. Fluidic and pneumatic peg boards were used to teach this portion of Power Technology.

Visual Communications Technology (includes offset lithography, black and white photography, linotype, silk-screen (hand-cut and photographic) and rubber-stamp making) - three Addressograph-Multigraph Model 1250 offset duplicators and one linotype machine.

Table 2

Percent of Noise Exposures of the 85 dBA/8 Hour Limit, Hearing Protection Worn in Laboratory at Queen Elizabeth Composite High School

Technology Taught	Noise Exposure	Hearing Protection	
		Yes	No
Electronics	7.3		X
Materials	73.9		X
Power	58.2		X
Visual Communications	N/T (Not Tested)		X

Data in Table 2 illustrate that a noise exposure was not recorded for Visual Communications Technology. The reason for a noise exposure not being recorded for this technology was that at the time the noise

dosimeter was in the school, this particular technology was going through a program change. A program change involved classroom instruction in the theories of the processes and the operation of equipment found in this technology area. During this time no practical learning activities were being taught; instruction concentrated on theory.

The percent noise exposures recorded for Electronics Technology was 7.3 which is well below the 50 percent level for concern advocated by the Occupational Hygiene Branch, Alberta Labour.

The percent noise exposures for Power Technology was 58.2, and for Materials Technology, 73.9. Both of these percent noise exposures were above the 50 percent level. The learning activities found in these two technologies are noise-generating but these noise levels are not for a sustained period of time.

M. E. LaZerte Composite High School

Industrial arts at M. E. LaZerte Composite High School is taught in three different rooms which are located in a part of the school that is referred to as the "vocational wing". There are five industrial arts teachers in this school.

Geometric Shape: the three laboratories are rectangular.

Surface Area: 1800 square feet (Materials Technology-Metals);
7200 square feet (Materials/Visual Communications Technology);
1800 square feet (Power Technology)

Ceiling: 20 feet high; ribbed concrete in both the Materials Technology (Metals) and the Power Technology laboratories; 10 feet high, waffle-pattern, cast concrete in the Materials/Visual Communications Technology area.

Wall: exterior walls of concrete blocks; interior walls of drywall construction in both Materials Technology (Metals) and the Power Technology laboratories; all walls in the Materials/Visual Communications Technology area are of drywall construction.

Floor: concrete in both the Materials Technology (Metals) and Power Technology laboratories; linoleum tile in the Materials/Visual Communications Technology.

Acoustical Treatment: none aside from the use of drywall and the occasional bulletin board.

Other: in the Materials/Visual Communications Technology laboratory there is a machine room which is a self-contained room that is separated from the rest of the laboratory by a glass and drywall partition. Also, there is a separate engine test room in the Power Technology area, as well as separate storage rooms and teachers' offices.

Learning Activities Taught: Materials Technology, Power Technology and Visual Communications Technology.

Following are the major pieces of capital equipment that may generate noise in each area of the three laboratories in this school.

Materials Technology (including woods, cold metals, sheet metal, plastics and materials testing) - Woodworking Equipment: drill press, grinder, wood lathe, band saw, circular saw, scroll saw, combination belt-disc sander, Uniplane, Metalworking Equipment: drill press, grinder, metal lathes, band saw, power hacksaw, shaper, milling machine, sand blaster, spot-welder, electric and gas welders, plus a variety of portable electric hand tools used to work either woods, plastics or

metals, drills, router, sander and sabre saw.

Power Technology (including conventional heat engines, small engine tune-up and overhaul, and electrical systems) - internal combustion engines in this area included a number of two and four stroke engines, the latter were either 6 or V8 cylinder engines. Also, the Power Technology area was equipped with a drill press, grinder, and valve grinder.

Visual Communications Technology (including offset lithography, black and white photography, layout and design, photo-typesetting, drafting and offset printing and production) - one Heidelberg offset press, two Addressograph-Multigraph Model 1250 offset duplicators, two paper folders.

Data in Table 3 show percent noise exposures for the three industrial arts laboratories of M. E. LaZerte. These data also show

Table 3

Percent of Noise Exposures of the 85 dBA/8 Hour Limit,
Hearing Protection Worn in Laboratory at
M. E. LaZerte Composite High School

Technology Taught	Noise Exposure	Hearing Protection	
		Yes	No
Electronics	N/O (Not Offered)		
Materials	57.6		X
Power	32.0		X
Visual Communications	16.0		X

whether or not hearing protection was worn by those working in the three technology areas.

Of the three percents in Table 3, the most hazardous area and the only one that exceeded the 50 percent level of concern, is the percent for the Materials Technology area, which was 57.6. The 32 percent for the Power Technology laboratory and the 16 percent for the Visual Communications Technology area, are well below the level for concern.

It would appear from these data that the likelihood of a hazard causing some degree of hearing impairment to develop in individuals working in these laboratories is minimal.

Data indicate that in these three laboratories, no form of hearing protection was worn by either the industrial arts teachers or the students who worked in these technologies.

Victoria Composite High School

The industrial arts laboratory at Victoria Composite High School is a single teacher laboratory that is located in a building separated from the main building of the school. This building is at the ground level.

Geometric Shape: rectangle; subdivided into seven smaller rooms of varying sizes.

Surface Area: 7200 square feet.

Ceiling Height: 15 feet high; exposed wood planks with steel girders.

Wall: exterior walls of concrete blocks; interior walls and partitions of drywall construction.

Floor: concrete throughout.

Acoustical Treatment: none.

Learning Activities Taught: Electronics Technology and Visual Communications Technology.

In this laboratory there are a number of pieces of capital equipment in each of these two areas that may be noise-generating. These pieces of equipment, by area, were:

Electronics Technology (including Electricity and Electronics, Computers and Electronic Calculators) - none reported.

Visual Communications Technology (includes offset lithography, black and white photography and mechanical drafting) - one A. B. Dick offset duplicator.

Victoria Composite High School was the only participating high school in the study that offered a single teacher laboratory. An average daily percent of 0.7 was recorded - a figure which is near negligible when compared to the 50 percent level for concern, urged by the Occupational Hygiene Branch, Alberta Labour.

A possible reason for this low figure might by the type of learning activities that the students were involved in during the week that the noise dosimeter was worn by the teacher. Another reason might be because of the fact that neither of the two noisiest areas - Power Technology and Materials Technology were being offered as a part of the industrial arts program in that school.

Data collected with the "Noise Exposure Survey Data Sheet" show that the industrial arts teacher and the students working in this facility did not wear any form of hearing protection.

Strathcona Composite High School

Industrial arts at this school is taught in four separate rooms which are located on the ground floor of a wing, attached to the main school building. There are four teachers that make-up the industrial arts staff at this school.

Geometric Shape: all four laboratories are rectangular.

Surface Area: ranges from 1600 to 2000 square feet per laboratory.

Ceiling: 15 feet; smooth plaster.

Wall: exterior walls are of concrete blocks; interior walls are of drywall construction.

Floor: concrete in the Electronics and Power Technology laboratories; hardwood floors in the Materials Technology and Visual Communications Technology laboratories.

Acoustical Treatment: none.

Other: each laboratory contained its own storage room and teacher's office, as well as a section that was used for classroom conference and instruction.

Learning Activities Taught: Electronics Technology, Materials Technology, Power Technology and Visual Communications Technology.

Where the various technologies are taught in an industrial arts laboratory, there exists a wide variety of capital equipment that can generate noise as this equipment is used to cut, shape, or form a material. These pieces of equipment in this laboratory were identified as follows:

Electronics Technology (includes Electricity and Electronics) -

none reported.

Materials Technology (includes woods, cold metals, sheet metal, and materials testing) - Woodworking Equipment: drill press, grinder, wood lathes, band saw, circular saw, jointer, shaper, radial arm saw, scroll saw, combination belt/disc sander, surface planer, mortiser and tenoner; Metalworking Equipment: drill press, grinder, metal lathes, band saw, shaper, power hacksaw, milling machine and welder, plus a variety of hand tools used to work with the materials found in this technology - router, drills and sanders.

Power Technology (includes conventional heat engines, small engine tune-up and overhaul, automobile tune-up, mechanical and electrical systems) - welders (both gas and arc); Metalworking Equipment such as: drill press, metal lathe, power hacksaw, forge area, rotary sanders and electrical drills, plus a number of internal combustion two and four cycle engines.

Visual Communications Technology (includes offset lithography, black and white photography, screen printing and mechanical drafting) - Addressograph-Multigraph Model 1250 offset duplicator.

In Table 4 there are data which show the percent of noise exposure for each of the four technologies taught in this school. These data also show that hearing protection was not part of the safety attire worn by those who worked in industrial arts at Strathcona Composite High School.

On the basis of the data in this table, it is readily apparent that the following technologies could be considered non-hazardous to an individual's hearing: Electronics, Power and Visual Communications. The percent of 128 for Materials Technology is a percent that is in

Table 4

Percent of Noise Exposures of the 85 dBA/8 Hour Limit,

Hearing Protection Worn in Laboratory at

Strathcona Composite High School

Technology Taught	Noise Exposure	Hearing Protection	
		Yes	No
Electronics	0		X
Materials	128		X
Power	16		X
Visual Communications	0		X

violation of the regulations prescribed in The Alberta Occupational Health and Safety Act (1976), namely that of the 85 dBA/8 hour limit. A percent of 128 is an indicator that should be of concern to those who teach and learn in this environment. Because of this high noise percentage, the possibility of hearing damage being sustained by either staff or students in this laboratory, is one which should not be overlooked.

Additional data in this table show that no form of hearing protection was worn by either staff or students working in these facilities.

Bonnie Doon Composite High School

The industrial arts laboratory in this school is located on the second floor of a two storey building. This laboratory is a four teacher facility.

Geometric Shape: elongated rectangle with a number of ancillary rooms.

Surface Area: 7600 square feet.

Ceiling: varies from a 7 foot acoustical tile ceiling to that of a 10 foot ribbed concrete ceiling.

Wall: exterior walls of concrete blocks; interior walls and partitions of drywall construction.

Floor: linoleum tile throughout.

Acoustical Treatment: none aside from the acoustically tiled ceiling which covers about one half of the laboratory, and the use of bulletin boards around the perimeter of the laboratory, on certain walls.

Other: In the Power Technology area of this laboratory there is a separate engine test room that is isolated from the rest of the laboratory. This room is well-ventilated to remove exhaust fumes and gases produced by the operation of internal combustion engines. In the woods area of the Materials Technology, there is a machine room that is isolated from the rest of the laboratory by a glass and drywall partition. Storage, teachers' offices and a conference room are separate from the rest of the laboratory as well.

Learning Activities Taught: Materials Technology, Power Technology and Visual Communications Technology.

The pieces of capital equipment that may generate noise in any of these teaching and learning activity areas are as follows:

Materials Technology (includes woods, cold metals, sheet metal, plastics and materials testing) - Woodworking Equipment: drill press, grinder, wood lathes, band saw, circular saw, jointer, shaper, radial

arm saw, scroll saw, Uniplane, combination belt/disc sander; Metalworking Equipment: drill press, grinder, metal lathes, band saw, shaper, power hacksaw, plus a variety of power hand tools used to work woods, plastics and metals, such as drills, sanders, disc grinders, router, circular saw and bayonet saw. Also present was a forge area that contained gas and arc welders.

Power Technology (includes conventional heat engines, small engine tune-up and overhaul, and electrical systems) - two and four stroke cycle, internal combustion engines.

Visual Communications Technology (includes offset lithography, black and white photography and mechanical drafting) - two Addressograph-Multigraph offset duplicators.

Included in Table 5 are data which show that the learning activities in the Visual Communications Technology area were the least noise-generating of the three technologies monitored, with an equivalent noise exposure percent of only 36 for the monitoring period. The corresponding percent for the Materials Technology area was 112, and for the Power Technology, 66. In both technologies, noise exposures were in excess of the 50 percent level. The 112 percent for noise exposure in the Materials Technology represents a violation of the 85 dBA/8 hour limit, prescribed in the regulations of The Alberta Occupational Health and Safety Act (1976).

Data in Table 5 also show that neither the teacher nor the students, in the industrial arts laboratories of Bonnie Doon Composite High School, wore hearing protection while in the laboratory.

Table 5

Percent of Noise Exposures of the 85 dBA/8 Hour Limit,

Hearing Protection Worn in Laboratory at

Bonnie Doon Composite High School

Technology Taught	Noise Exposure	Hearing Protection	
		Yes	No
Electronics	N/O		
Materials	112		X
Power	66		X
Visual Communications	36		X

Harry Ainlay Composite High School

At Harry Ainlay Composite High School, the industrial arts laboratory is classified as a two teacher, single laboratory and is located on the ground floor of the main school building. The characteristics of that laboratory are as follows:

Geometric Shape: rectangular.

Surface Area: 7200 square feet.

Ceiling: 10 feet; acoustical tile.

Wall: exterior walls of concrete; interior walls and partitions of glass and drywall construction.

Floor: linoleum tile throughout.

Acoustical Treatment: very little with the exception of the acoustical tile ceiling and the ocassional bulletin board around the laboratory.

Other: the major machines of the woods section of the Materials

Technology are located in a separate room at one end of the laboratory and are isolated by a glass and drywall partition. Also separate from the rest of the laboratory are the darkroom, storage room and teachers' office.

Learning Activities Taught: Materials Technology and Visual Communications Technology (which offered only photography, a non-noise generating area. Because of this, Visual Communications Techology was eliminated from the research).

The primary pieces of capital equipment that may be noise-generating in the Materials Technology are as follows: (includes woods, cold metals, sheet metal and materials testing) - Woodworking Equipment: drill press, grinder, wood lathe, band saw, circular saw, shaper, scroll saw, combination belt/disc sander, Uniplane; Metalworking Equipment: drill press, grinder, metal lathes, band saw, shaper, milling machine, power hacksaw, both arc and gas welders, plus a variety of power hand tools that included a router, circular saw, drills, bayonet saw and orbital sanders, all of which can be used to work the materials found in this technology.

The data from Table 6 indicate that neither the Electronics nor Power Technology areas were offered as a regular part of the industrial arts program at Harry Ainlay Composite High School. Further, the Visual Communications Technology area was not tested due to the fact that only photography was being offered, and none of the many other learning activities normally associated with this technology, were being offered. As a result, Visual Communications Technology was eliminated from the study. However, for the four and one-half days monitoring period, a percent of 153.6 was recorded in the Materials Technology. This percent is well in

Table 6

Percent of Noise Exposures of the 85 dBA/8 Hour Limit,

Hearing Protection Worn in Laboratory at

Harry Ainlay Composite High School

Technology Taught	Noise Exposure	Hearing Protection	
		Yes	No
Electronics	N/O		
Materials	153.6		X
Power	N/O		
Visual Communications	N/T		X

excess of, and in violation of, the 85 dBA/8 hour limitation and should generate concern for the hearing safety of the staff and students working in the industrial arts laboratory of this school.

A COMPARISON OF NOISE LEVEL AVERAGES FOR LIKE AREAS IN THE LABORATORIES OF PARTICIPATING SCHOOLS

Throughout this section attention will be focussed on the data contained in Table 7 which is a comprehensive table that includes data from the seven senior high schools that made-up the population of the study.

Each of the technology areas taught in the seven participating schools will be discussed individually to show how the noise exposure levels in each laboratory compared with the 85 dBA/8 hour exposure limit, prescribed in the regulations of The Alberta Occupational Health and Safety Act (1976).

Electronics Technology

Data in Table 7 show that of the seven participating schools, only four (57 percent) offered learning activities in Electronics Technology. Of the four laboratories that did offer this technology, three reported noise exposures that were less than 1 percent. The noise exposure for the fourth electronics laboratory measured 7.3 percent - a figure far below the 50 percent level for concern, advocated by the Occupational Hygiene Branch, Alberta Labour. The average noise exposure for this technology, in the four schools that offered electronics as a learning activity, was 2 percent.

It is interesting to note that on one occasion the 115 dBA level was exceeded in Electronics Technology at one of the research schools - Queen Elizabeth Composite High School. This was explained by the Electronics Technology teacher who stated that while wearing the noise dosimeter, he happened to walk through the woods area of the Materials Technology area, when the jointer and circular saw were in operation. The noise generated by these two woodworking machines was intense enough to activate the 115 dBA exceeded lamp.

Materials Technology

Data in Table 7 show that of the seven senior high school laboratories that were involved in this study, all but one (Victoria Composite) offered programs and learning activities in this technology. The remaining six laboratories recorded noise exposures ranging from a low of 57.6 percent to a high of 153.6 percent; with an average for the six schools of 99.9 percent of the 85 dBA/8 hour exposure limitation. Out of the these six laboratories, three exceeded, and thus violated, the

Table 7

Peak Noise Exposures as Percent

of the 85 dBA/8 Hour Limit

Technologies Taught

Composite High Schools	Electronics Technology	Materials Technology	Power Technology	Visual Communications Technology	Laboratory Average
McNally	0	74.6*	10.6*	0	21.3
Queen Elizabeth	7.3*	73.9*	58.2	N/T	46.5
M. E. LaZerte	N/O	57.6*	32.0*	16.0	35.2
Victoria	0.7	N/O	N/O	0.7	0.7
Strathcona	0	128.0*	16.0	0	36.0
Bonnie Doon	N/O	112.0*	66.0*	36.0	71.3
Harry Ainlay	N/O	153.6*	N/O	N/T	118.3
Area Average	2.0	99.9	36.6	10.5	

N/O = not offered
N/T = not tested
G = General
* = 115 dBA level exceeded

85 dBA/8 hour exposure limitation prescribed in the regulations of The Alberta Occupational Health and Safety Act (1976). Noise exposures in the remaining three laboratories were well above the 50 percent level for concern that is advocated by the Occupational Hygiene Branch, the regulatory agency of Alberta Labour.

Data in Table 7 also show that in all six of these laboratories, the 115 dBA level was exceeded. This fact is an indication that potentially dangerous levels, depending on the duration, may exist for those individuals working and learning in that environment. The Alberta Occupational Health and Safety Act (1976) regulations state than an intensity level of 115 dBA can be tolerated, without ear protection, for a time not to exceed 7.5 minutes per day ("Regulations Respecting the Protection of Workers From the Effects of Noise" Division 29 - Alberta Provincial Board of Health (1973, p. 3); now incorporated into The Alberta Occupational Health and Safety Act (1976)).

The lowest noise level recording of these six laboratories was that of 57.6 percent which was recorded at M. E. LaZerte. The teacher who taught the Materials Technology at this school pointed out the fact that the room that housed the major pieces of woodworking machinery in the woods area was actually used by staff and students as little as possible because this room lacked dust-collecting equipment.

Power Technology

From the data in Table 7, it is evident that only five of the seven senior high industrial arts laboratories, that were monitored, offered Power Technology. The noise exposures in these five schools ranged from a low of 10.6 percent to a high of 66 percent; with an

average of 36.6 percent of the 85 dBA/8 hour limit.

Of the five schools that offered a program in Power Technology, the noise exposures at two schools (40 percent) surpassed the 50 percent level for concern advocated by the regulatory agency.

Finally, the noise levels in three of the five schools (60 percent), exceeded the 115 dBA level of intensity. This fact raises questions with regard to what the actual peak noise levels, and the duration of those levels, might have been.

Visual Communications Technology

Of the seven senior high industrial arts laboratories that comprised the population of the study, only five (71 percent), offered a program in Visual Communications Technology. It will be remembered that because Harry Ainlay offered photography only, in its Visual Communications Technology, the laboratory where this technology was taught was eliminated from the research.

Of the five schools, one (Queen Elizabeth Composite) was not monitored due to the fact that a program change was in effect during the time that the research was being carried out at that school. Of the remaining four schools, all noise exposures were well below the 50 percent level for concern. Two of those four schools reported noise exposures of 0 percent, and the remaining two reported exposures of 16 percent and 36 percent. The average for noise exposure in Visual Communications Technology in the five schools was 13 percent; a percent which tends to support the supposition that this area is quite safe, in terms of a potential hearing hazard existing.

None of the five laboratories where Visual Communications

Technology was taught reported that the 115 dBA lamp had been activated at any time during the research.

A COMPARISON OF THE LABORATORY AVERAGES FOR ALL SCHOOLS

Data in Table 7 also show the laboratory averages for all of the technologies taught in each of the participating schools. These averages range from a low of 0.7 percent for Victoria Composite High School, to a high of 118.3 percent for Harry Ainlay Composite High School. The research population can be rank-ordered in this way: Victoria Composite High School - 0.7 percent; McNally Composite High School - 21.3 percent; M. E. LaZerte Composite High School - 35.2 percent; Strathcona Composite High School - 36 percent; Queen Elizabeth Composite High School - 46.5 percent; Bonnie Doon Composite High School - 71.3 percent; and Harry Ainlay Composite High School - 118.3 percent.

Of this population, the noise exposures in only two of the laboratories monitored (or 29 percent of the research population) exceeded the 50 percent level for concern, advocated by the Occupational Hygiene Branch, Alberta Labour. The remaining laboratory averages of the other five schools were all below the level of concern advocated by that regulatory agency.

ACTUAL TEACHING TIME IN THE LABORATORY

In any study of noise, the time that the individual is exposed to the noise, as well as the level and spectrum (i.e. frequency) of the noise, must be considered. Anything beyond the 85 dBA/8 hour limitation,

or, for the purpose of this study, beyond the 100 percent level, represents a violation of the prescribed regulations of The Alberta Occupational Health and Safety Act (1976). Beyond this percent, the likelihood of hearing damage, and a subsequent hearing loss being sustained by individuals working in such an environment, is greatly increased. In view of this fact, the actual teaching time that the industrial arts teacher spends, teaching in a noisy environment, becomes significant. Table 8 includes data which show the average number of hours, on a daily basis, that industrial arts teachers taught in their laboratories.

Table 8

Average Number of Hours Per Day Teaching Time in the Laboratory (200 days per annum)

School Laboratory	Hours
McNally Composite	4.0
Queen Elizabeth Composite	4.7
M. E. LaZerte Composite	4.6
Victoria Composite	5.25*
Strathcona Composite	4.0
Bonnie Doon Composite	4.0
Harry Ainlay Composite	4.0
Population Average	4.36

*The teacher reporting this figure included time which was also spent teaching a non-industrial arts subject.

The data show that the teaching time at participating laboratories varies from 4 to 5.25 hours per day, with the population average of 4.36 hours per day.

Chapter 4

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

The previous chapter analyzed and discussed the data that were generated by this study following the research methodology that was prescribed in the first chapter. The actual number of hours that industrial arts staff in the participating schools spend in their laboratories, was included as content of the third chapter.

This fourth and final chapter will summarize the research and present the findings of the study which is to be considered a pre-screening study. Briefly defined, a pre-screening study presents data that are one dimensional, instead of being two dimensional. The results of this study are one dimensional because the results are concerned with noise exposures only, instead of noise levels and time.

An integral part of this chapter are the conclusions and recommendations that resulted from this investigation.

SUMMARY

The Research Problem and Its Subproblems

The major problem of this study was to compare the operational noise exposure levels in each senior high industrial arts laboratory of the Edmonton Public School Board with the current regulations for noise exposure levels in an industrial environment, as prescribed in the regulations of The Alberta Occupational Health and Safety Act (1976).

In addition to researching the above problem, three subproblems concerning the noise exposure levels in each research school were also

investigated. These subproblems were:

1. How do the noise exposure levels in the various multiple activity areas, in each school, compare with one another?
2. How do the noise exposure levels in like areas, in participating schools, compare with one another?
3. How do the eight hour laboratory noise exposure averages, of all participating schools, compare with one another?

Related Literature

A review of the literature that was related to the topic of noise and noise exposure in educational settings was made. The result of that review revealed that no research has been completed in Alberta that dealt with measuring noise exposure levels in senior high school industrial arts laboratories. However, the literature review did uncover four studies that had been conducted and completed in the United States, that had definite implications and relevance for this research.

An integral part of the review of the literature was to research reference sources on the physical characteristics of, and the measurement of sound. Closely related to these two topics was the function and physiology of the human hearing mechanism and the physical effects that noise can have on man's hearing. The review of the literature also examined the health and safety standards for Alberta's industry, that were in effect at the time of the study. For the benefit of the reader who may not be familiar with industrial arts, the rationale for the multiple activity organizational pattern was given. Also included is an explanation of how a multiple activity laboratory should be organized as a learning environment.

Population

The population selected for the research included all of the senior high school industrial arts laboratories of the Edmonton Public School Board that offered a program of study in industrial arts that is based on the curriculum guides published by Alberta Education. The research population was comprised of seven schools and 25 industrial arts teachers who taught in these schools.

Instrumentation

The noise dosimeter, which is a portable electro-acoustical instrument used by occupational hygienists and industrial audiologists to measure noise level exposures, was used in this study to record data for analysis. These instruments must meet certain government specifications and stringent standards of operation, prior to being certified as being capable of producing accurate and reliable acoustic measurements. For these reasons, and because of the fact that they are used by professionals in the field of noise measurement, the noise dosimeters, used in this study, were considered reliable data-gathering instruments for this research.

The noise dosimeters used in this study were worn in the breast pockets of the industrial arts teachers involved in the research. Those teachers who wore the Bruel and Kjaer instrument wore the cable-attached microphone, clipped to the lapel of their laboratory jacket. Participants who wore the General Radio instrument, wore it clipped into their breast pocket in such a way that the microphone was unobstructed by the material of the jacket itself. This procedure was stringently followed and adhered to so that the maximum noise exposures could be recorded in

the closest vicinity to the ear itself.

Once activated, the noise dosimeters had the capability of accumulating noise level exposures continuously, for an equal or equivalent exposure time of eight hours at the 85 dBA level. The Alberta Occupational Health and Safety Act (1976) stipulates a maximum level/time exposure of 85 dBA for an actual or equivalent eight hour time period. The noise dosimeters offer a percentage readout of that level/time combination such that a readout of less than 100 percent would indicate a non-violation, while a readout over 100 percent would indicate a direct violation of the 85 dBA/eight hour regulation.

The noise dosimeters used in this study had an accessory feature that would automatically activate an indicator lamp when a level of 115 dBA was reached or exceeded at any point in time during the noise monitoring program.

Methodology

The methodology of the study involved contacting - by telephone, the Occupational Hygiene Branch, Alberta Labour, to obtain information with regard to provincial regulations for noise levels in industry and the type of instrument that is used by that Branch to measure noise level exposures in an industrial setting. This information that was requested was readily made available to the researcher.

The two noise dosimeter units that were used in this study were: the General Radio Model 1944 and a Bruel and Kjaer Model 4425. Dosimeters of different makes had to be used because of the fact that identical units, of the same trade name and model, were not available.

To secure permission to conduct the research in the schools, a

Cooperative Activities Form was completed and routed through the appropriate administrative channels of The University of Alberta and the Edmonton Public School Board. Approval to conduct the research was given in writing to the Department of Field Experiences, by the Director of Research, of the Edmonton Public School Board. A copy of this correspondence was sent to the researcher.

The principal and the industrial arts staff at each participating school were contacted by the researcher in order to establish a schedule of visits, when the researcher could travel to each school and describe the study and the role that the industrial arts teachers would have in the study. In addition, one industrial arts teacher at each school was asked to act as a liaison person with the researcher. The primary duties of the liaison person were to initiate the use of the noise dosimeter in the laboratory, supervise the rotation of the unit among different teachers for the monitoring period, and to record the data onto the "Noise Exposure Survey Data Sheet" that was provided to each school.

Following the prescribed schedule of visits, each of the seven senior high industrial arts laboratories was monitored for noise exposure over a four and one-half day period. The data were collected in each of the technology areas that were offered in participating schools, and were then recorded on the "Noise Exposure Survey Data Sheet". Information on this form included: the day that each multiple activity area was monitored; whether hearing protection was used by those working in the areas that were monitored; the percentage noise exposure readout (taken from the noise dosimeter); the elapsed time exposure (to the nearest quarter hour); and whether or not the 115 dBA lamp had been activated at some point during the use period. With the use of the

following conversion formula:

$$\frac{8}{B} \times A = 8 \text{ hour equivalent}$$

where B represents the number of hours of exposure and A represents the percentage readout given by the noise dosimeter unit; an equivalent eight hour noise exposure level - as a percentage of the 85 dBA/8 hour limit; and an eight hour laboratory average, were computed by the researcher and recorded in the appropriate column of the "Noise Exposure Survey Data Sheet" for each school.

The monitoring program began when the noise dosimeters and data sheets were delivered to the pilot school. This school was the first school on the list. This delivery was made on a Friday afternoon so that the research instrument would be in each school for a maximum period of four and one-half days. At the time of delivery, the details of the operation of the instrument and the procedures to be followed in recording the data on the data survey sheet were explained. The following Monday morning marked the beginning of the research cycle for participating schools, with the liaison person supervising this phase of the study. On Friday afternoons, the equipment and the completed data sheets were picked up, and the dosimeters and data sheets were delivered to the schools that were next on the schedule. This procedure was followed until all seven of the participating schools had been monitored and the required data collected.

Pilot Study

The pilot school was the first school to be monitored for noise exposures, and was one of the seven schools that formed the population of the study.

The pilot study had the following purposes: for the researcher to become familiar with the operation and use of the noise dosimeter to measure noise exposures, and to determine if the procedures of the research design were properly sequenced.

The results from the pilot school showed that the dosimeters used to record the required data, and the design of the study, were viable. These results were:

1. that the Electronics Technology area and the Visual Communications Technology area both reported noise exposures at 0 percent;
2. that the Power Technology area reported a level of 10.6 percent;
3. that the Materials Technology area reported a level of 74.6 percent, and that the 115 dBA level had been activated;
4. that the 8 hour laboratory average noise exposure was 23.0 percent.

FINDINGS AND CONCLUSIONS OF THE STUDY

The findings and conclusions of this pre-screening study are based on the data that were collected and analyzed and are summarized as follows:

1. that the possibility of a hearing hazard may exist in some of the schools of the population;
2. that noise exposures in both the Electronics Technology and Visual Communications Technology areas are so low as to be considered innocuous;
3. that noise exposures in the Power Technology area of all

schools are considered as a potential hearing safety hazard to both industrial arts staff and students working in that area. Research data show that in one-half of the industrial arts laboratories tested that offered this technology, noise exposure levels of 115 dBA and possibly greater were reported;

4. that noise exposures in the Materials Technology area in all six schools that offered this technology were the highest of any technology in the study, with all six schools reporting noise exposure levels of 115 dBA and possibly greater. These exposures if sustained over a period of time could result in some form of hearing impairment and hearing loss to the industrial arts staff and students working in this area;
5. that hearing protection was not worn by either the industrial arts staff or students in any of the technology areas of the schools that were part of this research;
6. that the majority of the industrial arts teachers who were involved in the study, expressed concern over the operational noise levels in the laboratories where they taught.

RECOMMENDATIONS

From the findings of this pre-screening study, which are based upon the industrial standards of the regulatory agency, the following recommendations are made to the following reference groups: the Edmonton Public School Board; the Occupational Hygiene Branch; the Teachers of Industrial Arts; and, to Teacher-Educators. Before the recommendations are made it is pointed out with emphasis, that the findings of this study are based upon industrial standards and not educational standards,

for noise.

Edmonton Public School Board

1. That a similar research study be initiated at the junior high school level in order to see how results compare.
2. That some form of hearing protection be supplied to the industrial arts staff, and possibly students as well, who work around noise-generating pieces of capital equipment in the Materials Technology area.
3. That some form of hearing protection be supplied to the industrial arts staff, and possibly students as well, who work in the engine test rooms of the Power Technology area.
4. That in terms of designing or renovating industrial arts laboratories, a high priority be given to the utilization of acoustically absorbing materials to reduce noise levels or to isolate noisy areas from the rest of the laboratory.
5. That further study be initiated in industrial arts to measure and to identify more definitive measurements concerning intensity, frequency and spectrum, so that base levels for these measurements can be established.

Occupational Hygiene Branch, Alberta Labour

1. That a program of hearing protection and conservation be initiated, with the provision for audiological assessment of industrial arts staff, and possibly students, at regular intervals.
2. Because industrial standards were used for measuring noise levels which are written for a time reference of eight hours

per day, in a working environment where steady-state noise may prevail, it is recommended that a new set of regulations be written by the Occupational Hygiene Branch, Alberta Labour, that would be applicable to, and appropriate for, the learning activities found in industrial education. Many of the learning activities associated with industrial arts and vocational education that create noise, are reduced in time from an eight hour period, and are normally of the intermittent variety.

Teachers of Industrial Arts

1. That the services of the regulatory agency in this province; namely the Occupational Hygiene Branch, Alberta Labour, be sought in order to assist in making additional measurements in industrial arts laboratories.
2. That a program of hearing safety be encouraged and practised by teachers and students within the industrial arts facilities of the province.

Teacher-Educators

1. It is recommended that a course in "safety" be designed that would include an in-depth study of the Regulations of The Alberta Occupational Health and Safety Act (1976) and that all recommended safety procedures prescribed in the Regulations be taught to the pre-service teacher. This course should include safety devices to be used, safety apparel to be worn - including eye and hearing protection, and safety procedures to be followed in operating machinery.

BIBLIOGRAPHY

BIBLIOGRAPHY

I. BOOKS

Barlow, M. L. History of industrial education in the United States. Peoria, Illinois: Chas. A. Bennett Co., Inc., 1967.

Bell, A. Noise. Geneva: World Health Organization, 1966.

Beranek, L. L. Acoustic measurements. New York: John Wiley and Sons, 1949.

________ (Ed.) Noise reduction. New York: McGraw-Hill, 1960.

________ (Ed.) Noise and vibration control. New York: McGraw-Hill, 1971.

Brown, R. D. Industrial arts laboratory planning and administration. Milwaukee: Bruce Publishing Co., 1969.

Burns, W. Noise and man. London: William Clowes and Sons Ltd., 1973.

Cochran, L. H. Innovative programs in industrial education. Bloomington, Illinois: McKnight and McKnight, 1970.

DeWeese, D. D. and Saunders, W. H. Textbook of otolaryngology. Saint Louis: C. V. Mosby Co., 1977.

Dosanjh, D. S., Hamernik, R. P., Henderson, D. and Mills, J. H. (Eds.) Effects of noise on hearing. New York: Raven Press, 1976.

Dublin, W. A. Fundamentals of sensorineural auditory pathology. Springfield, Illinois: Charles C. Thomas, 1976.

Feirer, J. and Lindbeck, J. Industrial arts education. New York: Center for Applied Research in Education, 1969.

Glorig, A. Noise and your ear. New York: Grune and Stratton, 1958.

Harris, C. M. (Ed.) Handbook of noise control. New York: McGraw-Hill, 1957.

Hosey, A. D. and Powell, C. H. (Eds.) Industrial noise: a guide to its evaluation and control. Washington: U.S. Printing Office, 1967.

Industrial noise manual (second edition). Detroit: American Industrial Hygiene Association, 1966.

Industrial noise manual (third edition). Akron, Ohio: American Industrial Hygiene Association, 1975.

Katz, J. (Ed.) *Handbook of clinical audiology*. Baltimore: Williams and Wilkins Co., 1972.

Kryter, K. D. *The effects of noise on man*. New York: Academic Press, 1970.

Modern school shop planning. Sound - its effect on teaching and learning, by J. W. Gilliland. Ann Arbor, Mich.: Prakken Publishing, 1978.

Olishifski, P. E. and Harford, E. R. (Eds) *Industrial noise and hearing conservation*. Chicago: National Safety Council, 1975.

Peterson, A. P. and Gross, E. E. *Handbook of noise measurement* (8th edition). Concord, Mass.: GenRad Inc., 1978.

Polyak, S. L., McHugh, G. and Judd, D. K. *The human ear*. New York: Sonotone Corp., 1946.

Prescod, S. V. *Audiological handbook of hearing disorders*. Toronto: Van Nostrand, Reinhold Co., Ltd., 1978.

Rodda, M. *Noise and society*. Edinburgh: Oliver and Boyd, 1967.

Sataloff, J. *Hearing loss*. Philadelphia: J. B. Lippincott Co., 1966.

________. *Industrial deafness: hearing, testing and noise measurement*. New York: McGraw-Hill, 1957.

Silvius, G. and Curry, E. *Teaching multiple activities in industrial education*. Bloomington, Illinois: McKnight and McKnight, 1956.

Thiessen, G. J. *Effects of noise on man*. Ottawa: National Research Council, 1976.

Webb, J. D. (Ed.) *Noise control in industry*. Colchester, Essex: Anchor Press Ltd., 1976.

II. REPORTS

Environmental health criteria for noise. World Health Organization, Brussels: Feb., 1977.

Fricke, J. E. and Ward, W. D. (Eds.) *Proceedings of the conference: noise as a public health hazard*. The American Speech and Hearing Association, Report No. 4, Washington, 1969.

Preitz, C. H. and Andrus, J. B. *The Alberta plan: teacher preparation*. A report presented at the 41st Annual Conference (8th International Conference) of the American Industrial Arts Association at San Antonio, Texas, 1979.

Technical report of the Edmonton noise survey. Prepared for the Department of the Environment, Province of Alberta, by Bolstadt Engineering Associates Ltd., Edmonton: Jan., 1973.

III. JOURNALS AND ARTICLES

Conn, D. O. The audio dosimeter. National Safety News, October 1972.

Harder, J. D. The Alberta industrial arts program. School Shop, 1968, 55.

Heffler, A. J. Hearing loss due to noise exposure. The Otolaryngologic Clinics of North America, 11, No. 3, October 1978. Philadelphia: W. B. Saunders, 1978.

Lipscomb, D. M. Noise induced sensorineural hearing loss. The Otolaryngologic Clinics of North America, 11, No. 1, February 1978. Philadelphia: W. B. Saunders, 1978.

May, C. R. Hearing loss associated with occupational exposure to noise. Canadian Sppech and Hearing Association Convention, 1970. Division of Industrial Health, Department of Health, Province of Alberta.

Mills, J. H. Temporary and permanent threshold shifts producted by nine day exposures to noise. The Journal of Speech and Hearing Research, 16, September 1973.

Preitz, C. H. Developing a program to individualize instruction. Journal of Industrial Teacher Education, 10, No. 3, Spring 1973. Published by the National Association of Industrial and Technical Teacher Educators.

Ward, W. D. The identification and treatment of noise induced hearing loss. The Otolaryngologic Clinics of North America, February 1969. Philadelphia: W. B. Saunders, 1969.

Yates, J. T., Ramsey, J. D., and Holland, J. W. Damage risk: an evaluation of the effects of exposure to 85 versus 90 dBA of noise. The Journal of Speech and Hearing Research, 19, June 1976.

IV. GOVERNMENT PUBLICATIONS

Alberta education and diploma requirements: a discussion paper prepared for the curriculum policies board. Department of Education, Alberta. Revised, Fall 1977.

Alberta industrial arts equipment list. Department of Education, Alberta, February 1973.

Handbook in industrial education. Department of Education, Alberta, 1976.

Industrial arts laboratory planning. Department of Education, Alberta, 1968.

Junior high industrial education guide. Department of Education, Alberta, 1976.

Noise regulations: the occupational health and safety act. Department of Labour, Alberta. Revised Proposal, June 1978.

School buildings regulations. Department of Education, Alberta, 1977.

V. DISSERTATIONS

Gallagher, J. E. A descriptive analysis of industrial arts in Alberta. (University of Alberta, 1963). Unpublished Master's thesis.

Harder, J. D. The development of the industrial arts program and its present status in the Province of Alberta. (Oregon State University, 1964). Unpublished Master's thesis.

Hicks, C. E. Noise pollution as a potential safety and health hazard within selected Utah industrial education laboratory facilities (Utah State University, 1973). (University Microfilms International, 1973)

Monfette, R. J. Survey of sound levels in selected school laboratories to determine compliance with provisions in the Occupational Safety and Health Act of 1970 (Wayne State University, 1974). (University Microfilms No. 74-29, 834)

Pontynen, B. A. An evaluation of noise levels in college welding laboratories and its effect on student hearing (Arizona State University, 1973). (University Microfilms International, 1973) (University Microfilms No. 73-18, 209)

Rost, L. D. A Study determining the effects on teacher-student interaction when wearing hearing protectors as an abatement device for noise control (Purdue University, 1974). (University Microfilms International, 1974) (University Microfilms No. 75-17, 277)

Smith, J. C. The development of industrial arts multiple-activity in Alberta. (University of Alberta, 1973). Unpublished Master's thesis.

VI. TECHNICAL MANUALS

Noise Dosimeter Type 1944, Including Type 1944-9701 Noise Exposure Monitor and Type 1944-9702 Noise Exposure Indicator. Concord, Mass.: The General Radio Co., August, 1972.

APPENDIX A

Included in this appendix are copies of the "Noise Exposure Survey Data Sheets" and the data that were collected at each of the seven senior high industrial arts laboratories that participated in the study.

APPENDIX A

NOISE EXPOSURE SURVEY DATA SHEET

Date survey completed March 19-23, 1979. Dosimeter trade name General Radio 1944

School McNally Composite High Serial number 886

DAY	AREA	Hearing Protection		% Noise Exposure (A)	NOISE DATA Elapsed Time Exposure In Hours* (B)	115 dBA Exceeded		8 hour Equivalent $\frac{8}{B} \times A = \%$
		YES	NO			YES	NO	
March 19	M/E		X	35/0	3.75/3.25	X	X	74.6/0
20			X					
21	M/P		X	14/2	3.75/3.75		X/X	29.8/4.3
22	P		X	7	5.25	X		10.6
23	V		X	0	1.25		X	0

* elapsed time is given to the nearest ¼ hour.

COMMENTS OR REMARKS CONCERNING NORMALCY OF TEST CONDITIONS: No data collected March 20 (liaison person's error)

AREA CODES
Electronics Technology (E)
Materials Technology (M)
General (G)
Power Technology (P)
Visual Communications (V)

8 hour day noise exposure laboratory average 21.3 %

$\frac{T}{n}$ = Lab. Av. %

APPENDIX A

NOISE EXPOSURE SURVEY DATA SHEET

Date survey completed March 19-23, 1979.

Dosimeter trade name Bruel & Kjaer 4425

School Queen Elizabeth Composite High

Serial number 578405

DAY	AREA				NOISE DATA			
		Hearing Protection		% Noise Exposure (A)	Elapsed Time Exposure In Hours* (B)	115 dBA Exceeded		8 hour Equivalent $\frac{8}{B} \times A = \%$
		YES	NO			YES	NO	
March 19	M		X	30	5.5		X	43.5
20	P		X	31	4.25		X	58.2
21	E		X	3	3.25	X		7.3
22	M		X	51	5.5	X		73.9
23	M		X	29	4		X	58.0

* elapsed time is given to the nearest ¼ hour.

COMMENTS OR REMARKS CONCERNING NORMALCY OF TEST CONDITIONS: No classes in Power, Graphics and Electronics on March 23 resulting in a "quiet day".

AREA CODES
Electronics Technology (E)
Materials Technology (M)
General (G)

Power Technology (P)
Visual Communications (V)

8 hour day noise exposure laboratory average 46.5 %

$\frac{T}{n}$ = Lab. Av. %

APPENDIX A

NOISE EXPOSURE SURVEY DATA SHEET

Date survey completed April 2-6, 1979.　　Dosimeter trade name Bruel & Kjaer 4425

School M. E. LaZerte Composite High　　Serial number 578405

DAY	AREA				NOISE DATA			
		Hearing Protection		% Noise Exposure (A)	Elapsed Time Exposure In Hours* (B)	115 dBA Exceeded		8 hour Equivalent $\frac{8}{B} \times A = \%$
		YES	NO			YES	NO	
April 2	P/M		X	5/9	1.25/1.25	X/X		32.0/57.6
2/3	M		X	4/25	1.25/5	X	X	25.6/40.0
4	M		X	2	1.25		X	12.8
5	M		X	3/5	1.25/1.25		X/X	19.2/32.0
6	V		X	5	2.5		X	16.0

* elapsed time is given to the nearest ¼ hour.

COMMENTS OR REMARKS CONCERNING NORMALCY OF TEST CONDITIONS:

Conditions reported as average.

AREA CODES
Electronics Technology (E)
Materials Technology (M)
General (G)

Power Technology (P)
Visual Communications (V)

8 hour day noise exposure laboratory average 35.2 %

$\frac{T}{n}$ = Lab. Av. %

APPENDIX A

NOISE EXPOSURE SURVEY DATA SHEET

Date survey completed April 2-6, 1979.   Dosimeter trade name General Radio 1944

School Victoria Composite High   Serial number 886

DAY	AREA	NOISE DATA						
		Hearing Protection		% Noise Exposure (A)	Elapsed Time Exposure In Hours* (B)	115 dBA Exceeded		8 hour Equivalent $\frac{8}{B} \times A = \%$
		YES	NO			YES	NO	
April 2	G		X	0	4.5		X	0
3	G		X	2	4.5		X	3.56
4	G		X	0	4.5		X	0
5	G		X	0	4.5		X	0
6	G		X	0	4.5		X	0

* elapsed time is given to the nearest ¼ hour.

COMMENTS OR REMARKS CONCERNING NORMALCY OF TEST CONDITIONS: Noise levels reported as being "average" for the week. Teacher reports no noise-generating equipment present in the laboratory.

AREA CODES
Electronics Technology (E)
Materials Technology (M)
General (G)
Power Technology (P)
Visual Communications (V)

8 hour day noise exposure laboratory average 0.71 %

$\frac{T}{n}$ = Lab. Av. %

APPENDIX A

NOISE EXPOSURE SURVEY DATA SHEET

Date survey completed April 23-27, 1979. Dosimeter trade name General Radio 1944

School Strathcona Composite High Serial number 886

DAY	AREA				NOISE DATA			
		Hearing Protection		% Noise Exposure (A)	Elapsed Time Exposure In Hours* (B)	115 dBA Exceeded		8 hour Equivalent $\frac{8}{B} \times A = \%$
		YES	NO			YES	NO	
April 23	M		X	40	2.6	X		128.0
23	P		X	5	2.6		X	16.0
24	E		X	0	2.6		X	0.0
24	P		X	2	1.3		X	12.8
25	V		X	0	4		X	0.0

* elapsed time is given to the nearest ¼ hour.

COMMENTS OR REMARKS CONCERNING NORMALCY OF TEST CONDITIONS: Conditions reported as "average".

AREA CODES
Electronics Technology (E)
Materials Technology (M)
General (G)
Power Technology (P)
Visual Communications (V)

8 hour day noise exposure laboratory average 36.0 %

$\frac{T}{n}$ = Lab. Av. %

APPENDIX A

NOISE EXPOSURE SURVEY DATA SHEET

Date survey completed April 23-27, 1979. Dosimeter trade name Bruel & Kjaer 4425

School Bonnie Doon Composite High Serial number 578405

DAY	AREA	Hearing Protection		% Noise Exposure (A)	NOISE DATA Elapsed Time Exposure In Hours* (B)	115 dBA Exceeded		8 hour Equivalent $\frac{8}{B} \times A = \%$
		YES	NO			YES	NO	
April 23	M		X	56	4		X	112.0
24	P		X	33	4	X		66.0
25	V		X	18	4		X	36.0
26	M		X	34	3	X		90.8
27	P		X	25	3.5	X		57.3

* elapsed time is given to the nearest ¼ hour.

COMMENTS OR REMARKS CONCERNING NORMALCY OF TEST CONDITIONS: Visual Communications reported as "quiet". All other areas "average conditions".

AREA CODES
Electronics Technology (E)
Materials Technology (M)
General (G)
Power Technology (P)
Visual Communications (V)

8 hour day noise exposure laboratory average 71.3 %

$\frac{T}{n}$ = Lab. Av. %

APPENDIX A

NOISE EXPOSURE SURVEY DATA SHEET

Date survey completed April 30 - May 4, 1979. Dosimeter trade name Bruel & Kjaer 4425

School Harry Ainlay Composite High Serial number 578405

DAY	AREA	Hearing Protection		% Noise Exposure (A)	NOISE DATA Elapsed Time Exposure In Hours* (B)	115 dBA Exceeded		8 hour Equivalent $\frac{8}{B} \times A = \%$
		YES	NO			YES	NO	
April 30	M		x	13	0.75	x		138.71
30	M		x	24	1.25	x		153.6
May 1	M		x	19	1	x		152.0
2	M		x	18	2		x	72.0
3	M		x	14	1.5		x	75.0

* elapsed time is given to the nearest ¼ hour.

COMMENTS OR REMARKS CONCERNING NORMALCY OF TEST CONDITIONS: Last two days reported as "very quiet".

AREA CODES
Electronics Technology (E)
Materials Technology (M)
General (G)
Power Technology (P)
Visual Communications (V)

8 hour day noise exposure laboratory average 118.3 %

$\frac{T}{n}$ = Lab. Av. %

APPENDIX B

In this appendix is included a copy of the Cooperative Activities Form which was sent out through the Division of Field Experiences, at the Faculty of Education, The University of Alberta, to the office of the Director of Research for the Edmonton Public School Board, in order to obtain permission to enter the schools and conduct the proposed research study. That permission was granted and follows the Cooperative Activities Form by way of a Letter of Approval from the Edmonton Public School Board, enclosed herein.

COOPERATIVE ACTIVITIES PROGRAM

1. Nature of Activity (check one)

Student Teaching Internship	______	Special Practicum	______
Demonstration/Experimentation	______	Research	YES

2. Organization to be Involved

Edmonton Public School System	YES	County of Strathcona	______
Edmonton Separate School System	______	N.A.I.T.	______
St. Albert Protestant/Separate School System	______	Other	______
U. of A. Faculty of ______			

3. Requestor (staff member)

Name Dr. C. H. Preitz Position Professor Date Feb. 12, 1979

Request made on behalf of Mr. Shawn T. Carson

4. Description of Activity - Include title, objectives, procedure, evaluation, techniques, etc.

TITLE: A COMPARISON BETWEEN THE ALBERTA OCCUPATIONAL HEALTH AND SAFETY STANDARDS (1973) AND THE OPERATIONAL NOISE LEVELS WITHIN THE SENIOR HIGH INDUSTRIAL ARTS LABORATORIES OF THE EDMONTON PUBLIC SCHOOL BOARD.

OBJECTIVES: Specifically, to conduct research within each of the seven senior high school laboratories of the E.P.S.B. and further, to ascertain whether or not operational noise exposure levels conform with the standards for industry, as established by the Alberta Occupational Health and Safety Act (1973).

PROCEDURE: This research will involve the following:

1) the placement of a portable noise dosimeter within each of the seven laboratories, on a rotational basis, for a period of one week each;
2) the pocket monitor to be worn by each of the I.A. teachers in each lab., on a rotational basis, for one day;
3) each day, simple data will be recorded by a volunteer "key person" (one of the teaching personnel), in each of the labs (3-5 min./day);
4) the researcher will transport the portable equipment and data sheet from one school to the next, on each and every Friday afternoon, beginning the first week in March, until research complete.

EVALUATION: Data will take the form of percentage noise exposure figures which will be compared to the standards for industry, noted above. Also, comparisons between different lab. areas in each school and each of the seven different labs will be made.

5. Anticipated value to requestor

Research data for the Master of Education Degree (thesis).

6. Anticipated value to cooperating organization

The organization will obtain valuable knowledge as to safety conditions within the senior high, industrial arts laboratories.

7. Estimate of cost (see remuneration guidelines)

There will be no cost to either the I.A. teachers or to the Board.

8. Suggested personnel, schools and times

PERSONNEL: all I.A. teachers at each of the schools named below.

SCHOOLS & TIMES: McNally (Mar. 5-9), Bonnie Doon (Mar. 12-16), Harry Ainlay (Mar. 19-23), M. E. LaZerte (Mar. 26-30), Queen Elizabeth (April 2-6), Strathcona (May 7-11), Victoria (May 14-18)

For Office Use Only

Approved by ____________ Division of Field Experiences Date ________

Approved by ____ Date ________

Subject to the following conditions:

(a) A report of the results of findings of this project is required by the cooperating school system (check one) yes X no ___

(b) Other

EDMONTON PUBLIC SCHOOL
10010 - 107A Avenue, Edmonton, Alberta T5H 0Z8, Telephone (403) 429-5621

March 16, 1979

Mr. W. A. Kiffiak
School Liaison Officer
Division of Field Experiences
University of Alberta
Edmonton, Alberta
T6G 2G5

COPY

Dear Mr. Kiffiak:

Re: Research Request - Mr. S. Carson - "A Comparison Between the Alberta Occupational Health and Safety Standards (1973) and the Operational Noise Levels With the Senior High Industrial Arts Laboratories of the Edmonton Public School Board

The above research request has been approved on a permissive basis following examination by our Department and in consultation with Mr. T. Miner, Director, Design Construction.

The principals of the following school have agreed to participate in the project. The requester should now contact the schools to make further arrangements with the principals or department heads.

Mr. W. Klufas	Bonnie Doon Composite	465-5461
Mr. N. Rebryna	Harry Ainlay Composite	434-8451
Mrs. E. Mills	M. E. LaZerte Composite	476-8611
Mr. F. Loewen	McNally Composite	469-4451
Mr. C. Lund	Queen Elizabeth Composite	476-8671
Contact: Mr. Gerry Mikysyshyn, Department Head		
Mrs. W. Phipps	Strathcona Composite	439-3957
Mr. D. Terriff	Victoria Composite	426-3010
Contact: Mr. H. Weissborn, Department Head		

We would appreciate receiving a copy of the results of the study as soon as they are available.

Sincerely yours,

Barbara Jonsson
Research Assistant

cc: C. Preitz, S. Carson, T. Miner, Principals, Dept. Heads

APPENDIX C

This appendix includes a list of schools that show the multiple activity areas offered in each school, and the numbers of teachers who taught industrial arts in each of the participating schools that made up the population of the study.

APPENDIX C

THE HIGH SCHOOLS AND THEIR RESPECTIVE INDUSTRIAL ARTS MULTIPLE-ACTIVITY AREAS AND NUMBER OF STAFF WITHIN THE EDMONTON PUBLIC SCHOOL BOARD

School		No. Teachers (I.A.)
Bonnie Doon Composite	DRAFTING GRAPHICS MATERIALS POWER	4
Harry Ainlay Composite	GRAPHICS MATERIALS	2
M. E. LaZerte Composite	ELECTRONICS GRAPHICS MATERIALS (3) POWER	6
McNally Composite	ELECTRONICS GENERAL GRAPHICS MATERIALS	4
Queen Elizabeth Composite	DRAFTING ELECTRONICS MATERIALS POWER VISUAL COMMUNICATIONS	5
Strathcona Composite	ELECTRONICS/POWER GENERAL MATERIALS/GRAPHICS	3
Victoria Composite	GENERAL	1

APPENDIX D

The research schedule of visits that were made to the research schools and the dates when each school was monitored to collect data for the study.

APPENDIX D

RESEARCH SCHEDULE OF VISITS TO THE SCHOOLS

Composite High Schools	Dates
McNally Queen Elizabeth	March 19 - 23
M. E. LaZerte Victoria	April 2 - 6
Bonnie Doon Strathcona	April 23 - 27
Harry Ainlay	April 30 - May 4

APPENDIX E

Sample correspondence to the industrial arts personnel at one school, in order to confirm the date and time that the site visit would take place.

DEPARTMENT OF INDUSTRIAL
AND VOCATIONAL EDUCATION
FACULTY OF EDUCATION
THE UNIVERSITY OF ALBERTA

March 19, 1979

Dear

Just a note to confirm the following time slot, April 2 to April 6, during which time a noise level exposure survey will be conducted in the industrial arts laboratories of ________________________.

Again, I would like to meet with you, and interested staff, very briefly this Friday afternoon (i.e., Friday, March 23) at 2:30 p.m. in order to explain and to demonstrate the use of the test equipment to be used in this study.

My thanks for your cooperation in this regard.

Very sincerely,

Shawn T. Carson

Shawn T. Carson

P.S. If any problems or questions do arise between now and the completion of the research, please do not hesitate to contact me through the Department.

645 EDUCATION SOUTH, EDMONTON, ALBERTA, CANADA • T6G 2G5 • TELEPHONE (403) 432-3678

APPENDIX F

Copies of letters of request that were mailed to publishers and a sample copy of a letter of permission received from a publisher granting the researcher permission to use copyright material in the research.

DEPARTMENT OF INDUSTRIAL
AND VOCATIONAL EDUCATION

FACULTY OF EDUCATION
THE UNIVERSITY OF ALBERTA

February 13, 1979

The National Safety Council
425 North Michigan Ave.
CHICAGO, Illinois

Dear Sirs:

I am writing to request permission to use a number of the charts, diagrams, drawings and plates as presentational material in my Master of Education thesis, from the following source:

> Olishifski, J. B. and Hardord, E. R. Industrial Noise and Hearing Conservation. Chicago: National Safety Council, 1975.

I can assure you that the said material will not be published, and will be used solely for thesis preparation only.

I would very much appreciate the favour of your early reply.

Very sincerely,

Shawn T. Carson

Shawn T. Carson
Graduate Student

645 EDUCATION SOUTH, EDMONTON, ALBERTA, CANADA • T6G 2G5 • TELEPHONE (403) 432-3678

DEPARTMENT OF INDUSTRIAL
AND VOCATIONAL EDUCATION

QUAECUMQUE VERA

FACULTY OF EDUCATION
THE UNIVERSITY OF ALBERTA

February 13, 1979

J. B. Lippincott Co.
of Canada Ltd.
75 Horner Ave.
TORONTO, Ontario

Dear Sirs:

I am writing to request permission to use a number of the diagrams, charts, drawings and plates as presentational material in my Master of Education thesis, from the following source:

> Sataloff, J. Hearing Loss. Philadelphia: J. B. Lippincott Co., 1966.

I can assure you that the said material will not be published, and will be used solely for thesis presentation only.

I would very much appreciate the favour of your early reply.

Very sincerely,

Shawn T. Carson

Shawn T. Carson
Graduate Student

645 EDUCATION SOUTH, EDMONTON, ALBERTA, CANADA • T6G 2G5 • TELEPHONE (403) 432-3678

J. B. LIPPINCOTT COMPANY
East Washington Square
Philadelphia, Pa. 19105

March 26, 1979

Shawn T. Carson
Graduate Student
Department of Industrial and
Vocational Education
Faculty of Education
University of Alberta
Edmonton, Alberta T6G 0Y1

Dear Shawn:

Thank you for your request of February 13 (which was never received at this office) for use of "diagrams, charts, drawings and plates," in your Master's Thesis, from our HEARING LOSS by J. Sataloff.

We are pleased to grant you permission to use twelve figures of your choosing in your thesis. If there are any figures which you want to use which give credit to another source in the credit line after the legend, you will have to write to that source for permission.

We assume, of course, that you will give full credit to author, publisher, book and include the copyright date.

I would appreciate it if you will send me a list of those figures you will be using.

You may be interested to know that a new edition of Sataloff will be published soon.

Best wishes for the success of your Master's program.

Sincerely yours,

E. Jean Hyslop
Permissions Editor
Health Sciences Division